Ontario Provincial Standards for Roads and Public Works

- Volume 7 -

MUNICIPAL-ORIENTED

OPS GENERAL CONDITIONS OF CONTRACT AND GENERAL & CONSTRUCTION SPECIFICATIONS

Ontario

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Ministry of Transportation, Ontario
and the
Municipal Engineers Association

Municipal
Engineers
Association

MANUAL REVISION RECORD

Municipal-Oriented

Volume 7 – OPS General Conditions of Contract and General & Construction Specifications

This record should remain in the manual at all times. Revisions are numbered sequentially. This sheet should be filled in after each revision has been placed into the manual. It will quickly indicate to users whether the contents of the manual are up-to-date.

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8	Nov 2014	Included in new manuals	32		
9	Apr 2015	Included in new manuals	33		
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11	Apr 2016	Included in new manuals	35		
12	Nov 2016	Included in new manuals	36		
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18	Nov 2019	Included in new manuals	42		
19	Nov 2020	Included in new manuals	43		
20	Apr 2021	Included in new manuals	44		
21	Nov 2021	Included in new manuals	45		
22	Apr 2022	Included in new manuals	46		
23	Nov 2022	Included in new manuals	47		
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Nov 2016	335	Cold In-Place Recycling with Expanded Asphalt
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Nov 2021	360	Full Depth Repair of Concrete Pavement or Concrete Base
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DATE	OPSS.MUNI	TITLE
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SECTION GC 1.0 - INTERPRETATION

GC 1.01 Captions

.01 The captions appearing in these General Conditions have been inserted as a matter of convenience and for ease of reference only and in no way define, limit, or enlarge the scope or meaning of the General Conditions or any provision hereof.

GC 1.02 Abbreviations

.01 The abbreviations on the left below are commonly found in the Contract Documents and represent the organizations and phrases listed on the right:

"AASHTO"	-	American Association of State Highway Transportation Officials
“ACI”	-	American Concrete Institute
"ANSI"	-	American National Standards Institute
"ASTM"	-	ASTM International
"AWG"	-	American Wire Gauge
"AWWA"	-	American Water Works Association
“CCIL”	-	Canadian Council of Independent Laboratories
"CGSB"	-	Canadian General Standards Board
"CSA"	-	CSA Group - formerly Canadian Standards Association
"CWB"	-	Canadian Welding Bureau
"GC"	-	General Conditions
“ISO”	-	International Organization for Standardization
"MECP"	-	Ontario Ministry of the Environment, Conservation and Parks
"MTO"	-	Ontario Ministry of Transportation
"MUTCD"	-	Manual of Uniform Traffic Control Devices, published by MTO
“OHSA”	-	Ontario Occupational Health and Safety Act
“OLS”	-	Ontario Land Surveyor
"OPS"	-	Ontario Provincial Standard
"OPSD"	-	Ontario Provincial Standard Drawing
"OPSS"	-	Ontario Provincial Standard Specification
“OTM”	-	Ontario Traffic Manual
"PEO"	-	Professional Engineers Ontario
"SAE"	-	SAE International
“SCC”	-	Standards Council of Canada
"SSPC"	-	The Society for Protective Coatings
"UL"	-	Underwriters Laboratories
"ULC"	-	Underwriters Laboratories Canada
“WHMIS”	-	Workplace Hazardous Materials Information System
“WSIB”	-	Workplace Safety & Insurance Board

GC 1.03 Gender and Singular References

.01 References to the masculine or singular throughout the Contract Documents shall be considered to include the feminine and the plural and vice versa, as the context requires.

GC 1.04 Definitions

.01 For the purposes of the Contract Documents the following definitions shall apply:

Abnormal Weather means an extreme climatic condition characterized by wind speed, air temperature, precipitation, or snow fall depth, that is less than or greater than 1-1/2 standard deviations from the mean determined from the weather records of the 25-year period immediately preceding the tender opening date.

Actual Measurement means the field measurement of that quantity within the approved limits of the Work.

Addenda means any additions or change in the Tender documents issued by the Owner prior to Tender closing.

Additional Work means work not provided for in the Contract Documents and not considered by the Contract Administrator to be essential to the satisfactory completion of the Contract within its intended scope.

Agreement means the agreement between the Owner and the Contractor for the performance of the Work that is included in the Contract Documents.

Base means a layer of Material of specified type and thickness placed immediately below the pavement, driving surface, finished grade, curb and gutter, or sidewalk.

Business Day means any Day except Saturdays, Sundays, and statutory holidays.

Certificate of Subcontract Completion means the certificate issued by the Contract Administrator in accordance with clause GC 8.02.04.02, Certification of Subcontract Completion.

Certificate of Substantial Performance means the certificate issued by the Contract Administrator at Substantial Performance.

Change Directive means any written instruction signed by the Owner, or by the Contract Administrator where so authorized, directing that a Change in the Work or Extra Work be performed.

Change in the Work means the deletion, extension, increase, decrease, or alteration of lines; grades; dimensions; quantities; methods; drawings; substantial changes in geotechnical, subsurface, surface, or other conditions; changes in the character of the Work to be done; or Materials of the Work or part thereof, within the intended scope of the Contract.

Change Order means a written amendment to the Contract signed by the Contractor and the Owner, or the Contract Administrator where so authorized, covering contingencies, a Change in the Work, Extra Work, Additional Work; and establishing the basis for payment and the time allowed for the adjustment of the Contract Time.

Completion means contract completion as set out in the Construction Act.

Completion Certificate means the certificate issued by the Contract Administrator at Completion.

Completion Payment means the payment described more particularly in clause GC 8.02.04.07.

Construction Act means as set out in the Construction Act, R.S.O. 1990, c. C.30**,** as amended.

Constructor means, for the purposes of, and within the meaning of the Occupational Health and Safety Act, R.S.O. 1990, c.O.1, as amended and amendments thereto, the Contractor who executes the Contract.

Contract means the undertaking by the Owner and the Contractor to perform their respective duties, responsibilities, and obligations as prescribed in the Contract Documents.

Contract Administrator means the person, partnership, or corporation designated by the Owner to be the Owner's representative for the purposes of the Contract.

Contract Documents mean the executed Agreement between the Owner and the Contractor, Tender, General Conditions of Contract, Supplemental General Conditions of Contract, Standard Specifications, Special Provisions, Contract Drawings, Addenda incorporated in a Contract Document before the execution of the Agreement, such other documents as may be listed in the Agreement, and subsequent amendments to the Contract Documents made pursuant to the provisions of the Agreement.

Contract Drawings or **Contract Plans** mean drawings or plans, any Geotechnical Report, any Subsurface Report, and any other reports and information provided by the Owner for the Work, and without limiting the generality thereof, may include soil profiles, foundation investigation reports, reinforcing steel schedules, aggregate sources list, Quantity Sheets, and cross-sections.

Contract Time means the time stipulated in the Contract Documents for Substantial Performance or Completion of the Work, including any extension of time made pursuant to the Contract Documents.

Contractor means the person, partnership, or corporation undertaking the Work as identified in the Agreement.

Control Monument means any horizontal or vertical (benchmark) monument that is used to lay out the Work.

Controlling Operation means any component of the Work that, if delayed, may delay the completion of the Work.

Cut-Off Date means the date up to which payment shall be made for Work performed.

Daily Work Records mean daily Records detailing the number and categories of workers and hours worked or on standby, types and quantities of Equipment and number of hours in use or on standby, and description and quantities of Material utilized.

Day means a calendar day.

Drawings or **Plans** mean any Contract Drawings or Contract Plans, or any Working Drawings or Working Plans, or any reproductions of drawings or plans pertaining to the Work.

End Result Specification means specifications that require the Contractor to be responsible for supplying a product or part of the Work. The Owner accepts or rejects the final product or applies a price adjustment that is commensurate with the degree of compliance with the specification.

Engineer means a professional engineer licenced by the Professional Engineers of Ontario to practice in the Province of Ontario.

Equipment means all machinery and equipment used for preparing, fabricating, conveying or erecting the Work and normally referred to as construction machinery and equipment.

Estimate means a calculation of the quantity or cost of the Work or part of it depending on the context.

Extra Work means work not provided for in the Contract as awarded but considered by the Contract Administrator to be essential to the satisfactory completion of the Contract within its intended scope, including unanticipated Work required to comply with legislation and regulations that affect the Work.

Final Acceptance means the date on which the Contract Administrator determines that the Work has passed all inspection and testing requirements and the Contract Administrator is satisfied that the Contractor has rectified all imperfect Work and has discharged all of the Contractor's obligations under the Contract Documents.

Final Acceptance Certificate means the certificate issued by the Contract Administrator at Final Acceptance of the Work.

Final Detailed Statement means a complete evaluation prepared by the Contract Administrator showing the quantities, unit prices, and final dollar amounts of all items of Work completed under the Contract, including variations in tender items and Extra Work, all as set out in the same general form as the monthly Estimates.

Geotechnical Report means a report or other information identifying soil, rock, and ground water conditions in the area of any proposed Work.

Grade means the required elevation of that part of the Work.

Hand Tools means tools that are commonly called tools or implements of the trade and include small power tools.

Highway means a common and public highway any part of which is intended for or used by the general public for the passage of vehicles and includes the area between the lateral property lines thereof.

Inclement Weather means weather conditions or conditions resulting directly from weather conditions that prevent the Contractor from proceeding with a Controlling Operation**.**

Lot means a specific quantity of Material or a specific amount of construction normally from a single source and produced by the same process.

Lump Sum Item means a tender item indicating a portion of the Work for which payment will be made at a single tendered price. Payment is not based on a measured quantity, although a quantity may be given in the Contract Documents.

Major Item means any tender item that has a value, calculated based on its actual or estimated tender quantity, whichever is the larger, multiplied by its tender unit price, which is equal to or greater than the lesser of,

a) $100,000, or

b) 5% of the total tender value calculated based on the total of all the estimated tender quantities and the tender unit prices.

Material means Material, machinery, equipment and fixtures forming part of the Work.

Monument means either a Property Monument or a Control Monument.

Owner means the party to the Contract for whom the Work is being performed, as identified in the Agreement, and includes, with the same meaning and import, "Authority."

Pavement means a wearing course or courses placed on the Roadway and consisting of asphaltic concrete, hydraulic cement concrete, Portland cement concrete, or plant or road mixed mulch.

Performance Bond means the type of security furnished to the Owner to guarantee completion of the Work in accordance with the Contract and to the extent provided in the bond.

Plan Quantity means that quantity as computed from within the boundary lines of the Work as shown in the Contract Documents.

Project means the construction of the Work as contemplated by this Contract.

Proper Invoice has the meaning as set out in the Construction Act.

Property Monument means any property bar, concrete pillar, rock post, cut cross or other object that marks the boundary between real property ownership.

Quality Assurance (QA) means a system or series of activities carried out by the Owner to ensure that Work meets the specified requirements.

Quality Control (QC) means a system or series of activities carried out by the Contractor, Subcontractor, supplier, and manufacturer to ensure that Work meets the specified requirements.

Quantity Sheet means a list of the quantities of Work to be done.

Quarried Rock means Material removed from an open excavation made in a solid mass of rock that, prior to removal, was integral with the parent mass.

Quarry means a place where aggregate has been or is being removed from an open excavation made in a solid mass of igneous, sedimentary, or metamorphic rock or any combination of these that, prior to removal, was integral with the parent areas.

Rate of Interest means the prejudgment interest rate determined under subsection 127(2) of the *Courts of Justice Act* or, if the contract or subcontract specifies a different interest rate for the purpose, the greater of the prejudgment interest rate and the interest rate specified in the contract or subcontract.

Records mean any books, payrolls, accounts, or other information that relate to the Work or any Change in the Work, Extra Work, Additional Work or claims arising therefrom.

Roadway means that part of the Highway designed or intended for use by vehicular traffic and includes the Shoulders.

Shoulder means that portion of the Roadway between the edge of the travelled portion of the wearing surface and the top inside edge of the ditch or fill slope.

Special Provisions mean directions containing requirements specific to the Work.

Standard Drawing or Standard Specification means a standard practice required and stipulated by the Owner for performance of the Work.

Statutory Holdback means the holdbacks required under the Construction Act.

Subbase means a layer of Material of specified type and thickness between the Subgrade and the Base.

Subcontractor means a person, partnership or corporation undertaking the execution of a part of the Work by virtue of an agreement with the Contractor.

Subgrade means the earth or rock surface, whether in cut or fill, as prepared to support the pavement structure, consisting of Base, Subbase, and Pavement.

Substantial Performance has the meaning as set out in the Construction Act, R.S.O. 1990, c. C.30**,** as amended.

Subsurface Report means a report or other information identifying the location of Utilities, concealed and adjacent structures, and physical obstructions that fall within the influence of the Work.

Superintendent means the Contractor's authorized representative in charge of the Work and who shall be a “competent person” within the meaning of the definition contained in the Occupational Health and Safety Act, R.S.O. 1990, c. 0.1, as amended.

Surety means the person, partnership or corporation, other than the Contractor, licensed in Ontario to transact business under the Insurance Act, R.S.O. 1990, c.I.8, as amended, executing a bond provided by the Contractor.

Tender means an offer in writing from the Contractor, submitted in the format prescribed by the Owner, to complete the Work.

Time and Material means costs calculated according to clause GC 8.02.05, Payment on a Time and Material Basis.

Utility means an aboveground or underground facility maintained by a municipality, public utility authority or regulated authority and includes services such as sanitary sewer, storm sewer, water, electric, gas, oil, steam, data transmission, telephone, and cable television.

Warranty Period means the applicable time period according to clause GC 7.16.02, Warranty.

Work means the total construction and related services required by the Contract Documents.

Working Area means all the lands and easements owned or acquired by the Owner for the construction of the Work.

Working Day means any Day,

a) except Saturdays, Sundays and statutory holidays;

b) except a Day as determined by the Contract Administrator, on which the Contractor is prevented by inclement weather or conditions resulting immediately therefrom, from proceeding with a Controlling Operation. For the purposes of this definition, this shall be a Day during which the Contractor cannot proceed with at least 60% of the normal labour and Equipment force effectively engaged on the Controlling Operation for at least 5 hours;

c) except a Day on which the Contractor is prevented from proceeding with a Controlling Operation, as determined by the Contract Administrator by reason of,

    i. any breach of the Contract by the Owner or if such prevention is due to the Owner, another contractor hired by the Owner, or an employee of any one of them, or by anyone else acting on behalf of the Owner.

    ii. non-delivery of Owner supplied Materials.

    iii. any cause beyond the reasonable control of the Contractor that can be substantiated by the Contractor to the satisfaction of the Contract Administrator.

Working Drawings or **Working Plans** means any Drawings or Plans prepared by the Contractor for the execution of the Work and may, without limiting the generality thereof, include formwork, falsework, and shoring plans; Roadway protection plans; shop drawings; shop plans; or erection diagrams.

GC 1.05 Ontario Traffic Manual

.01 All references in the Contract Documents to the MUTCD, including all Parts and Divisions thereof, or MTO Traffic Control Manual for Roadway Work Operations, or Traffic Control Manual for Roadway Operations Field Edition are hereby deleted and replaced by all currently available books which make up the Ontario Traffic Manual.

GC 1.06 Final Acceptance

.01 For the purposes of determining whether Final Acceptance has occurred, the Contract Administrator shall not take into account, in determining the discharge of the Contractor's obligations, any warranty obligation of the Contractor to the extent that the warranty extends beyond 12 months after Substantial Performance.

GC 1.07 Interpretation of Certain Words

.01 The words "acceptable," "approval," "authorized," "considered necessary," "directed," "required," "satisfactory," or words of like import, shall mean approval of, directed, required, considered necessary, or authorized by and acceptable or satisfactory to the Contract Administrator, unless the context clearly indicates otherwise.

SECTION GC 2.0 - CONTRACT DOCUMENTS

GC 2.01 Reliance on Contract Documents

.01 The Owner warrants that the information furnished in the Contract Documents can be relied upon with the following limitations or exceptions:

a) Based on available information at the time of the contract, the location of all mainline underground Utilities that may affect the Work shall be shown to a tolerance of:

i. 1 m horizontal, and
ii. 0.3 m vertical

.02 The Owner does not warrant or make any representation with respect to:

a) interpretations of data or opinions expressed in any Subsurface Report available for the perusal of the Contractor, that are not included as part of the Contract Documents, and

b) other information specifically excluded from this warranty.

GC 2.02 Order of Precedence

.01 In the event of any inconsistency or conflict in the contents of the following documents, such documents shall take precedence and govern in the following descending order:

a) Agreement

b) Addenda

c) Special Provisions

d) Contract Drawings

e) Standard Specifications

f) Standard Drawings

g) Tender

h) Supplemental General Conditions

i) OPSS.MUNI 100 General Conditions of Contract

j) Working Drawings

Later dates shall govern within each of the above categories of documents.

.02 In the event of any conflict among or inconsistency in the information shown on Drawings, the following rules shall apply:

a) Dimensions shown in figures on a Drawing shall govern where they differ from dimensions scaled from the same Drawing;

b) Drawings of larger scale shall govern over those of smaller scale;

c) Detailed Drawings shall govern over general Drawings; and

d) Drawings of a later date shall govern over those of an earlier date in the same series.

.03 In the event of any inconsistency or conflict in the contents of Standard Specifications the following descending order of precedence shall govern:

a) Owner's Standard Specifications

b) Ontario Provincial Standard Specifications

c) Other standards referenced in OPSSs and OPSDs (e.g., CSA, CGSB, ASTM, and ANSI).

.04 The Contract Documents are complementary, and what is required by any one shall be as binding as if required by all.

SECTION GC 3.0 - ADMINISTRATION OF THE CONTRACT

GC 3.01 Contract Administrator's Authority

.01 The Contract Administrator shall be the Owner's representative during construction and until the issuance of the Completion Certificate or the issuance of the Final Acceptance Certificate, whichever is later. All instructions to the Contractor, including instructions from the Owner, shall be issued by the Contract Administrator. The Contract Administrator shall have the authority to act on behalf of the Owner only to the extent provided in the Contract Documents.

.02 All claims, disputes and other matters in question relating to the performance and the quality of the Work or the interpretation of the Contract Documents shall be referred to the Contract Administrator in writing by the Contractor.

.03 The Contract Administrator may inspect the Work for its conformity with the Contract Documents, and to record the necessary data to establish payment quantities under the schedule of tender quantities and unit prices or to assess the value of the Work completed in the case of a lump sum price Contract.

.04 The Contract Administrator shall provide an estimate of the amounts owing to the Contractor under the Contract as provided for in section GC 8.0, Measurement and Payment.

.05 The Contract Administrator, to not cause delay in the schedule, shall, with reasonable promptness, review and take appropriate action upon the Contractor's submissions such as shop drawings, product data, and samples in accordance with the Contract Documents .

.06 The Contract Administrator shall investigate all allegations of a Change in the Work made by the Contractor and issue appropriate instructions.

.07 The Contract Administrator shall prepare Change Directives and Change Orders for the Owner’s approval.

.08 Upon written application by the Contractor, the Contract Administrator and the Contractor shall jointly conduct an inspection of the Work to establish the date of Substantial Performance of the Work or the date of Completion of the Work or both.

.09 The Contract Administrator shall be, in the first instance, the interpreter of the Contract Documents and the judge of the performance thereunder by both parties to the Contract. Interpretations and decisions of the Contract Administrator shall be consistent with the intent of the Contract Documents and, in making these decisions, the Contract Administrator shall not show partiality to either party.

.10 The Contract Administrator shall have the authority to reject any part of the Work or Material that does not conform to the Contract Documents.

.11 In the event that the Contract Administrator determines that any part of the Work performed by the Contractor is defective, whether the result of poor workmanship the use of defective Material or damage through carelessness or other act or omission of the Contractor and whether or not incorporated in the Work or otherwise fails to conform to the Contract Documents, then the Contractor shall if directed by the Contract Administrator promptly, as directed by the Contract Administrator, remove the Work and replace, make good, or re-execute the Work at no additional cost to the Owner.

.12 Any part of the Work destroyed or damaged by such removals, replacements, or re-executions shall be made good, promptly, at no additional cost to the Owner.

.13 If, in the opinion of the Contract Administrator it is not expedient to correct defective Work or Work not performed in accordance with the Contract Documents, the Owner may deduct from monies otherwise due to the Contractor the difference in value between the Work as performed and that called for by the Contract Documents amount that will be determined in the first instance by the Contract Administrator.

.14 Notwithstanding any inspections made by the Contract Administrator or the issuance of any certificates or the making of any payment by the Owner, the failure of the Contract Administrator to reject any defective Work or Material shall not constitute acceptance of defective Work or Material.

.15 The Contract Administrator shall have the authority to temporarily suspend the Work for such reasonable time as may be necessary:

a) to facilitate the checking of any portion of the Contractor's construction layout;

b) to facilitate the inspection of any portion of the Work; or

c) for the Contractor to remedy its non-compliance with any provisions of the Contract Documents.

The Contractor shall not be entitled to any compensation for suspension of the Work in these circumstances.

.16 The Owner has the right to terminate the Contract for wilful or persistent violation by the Contractor or its workers of any applicable laws or bylaws, including but not limited to, the Occupational Health and Safety Act legislation and regulations, Workplace Safety and Insurance Board Act, and Regulation 347 of the Environmental Protection Act.

.17 If the Contract Administrator determines that any worker employed on the Work is incompetent, as defined by the Occupational Health and Safety Act, or is disorderly, then the Contract Administrator shall provide written notice to the Contractor and the Contractor shall immediately remove the worker from the Working Area. Such worker shall not return to the Working Area without the prior written consent of the Contract Administrator.

GC 3.02 Working Drawings

.01 The Contractor shall arrange for the preparation of clearly identified and dated Working Drawings as called for by the Contract Documents.

.02 The Contractor, to not cause delay in the Work, shall submit Working Drawings to the Contract Administrator with reasonable promptness and in orderly sequence . If either the Contractor or the Contract Administrator so requests, they shall jointly prepare a schedule fixing the dates for submission and return of Working Drawings. Working Drawings shall be submitted in printed form. At the time of submission, the Contractor shall notify the Contract Administrator in writing of any deviations from the Contract Documents that exist in the Working Drawings.

.03 The Contract Administrator shall review and return Working Drawings in accordance with an agreed upon schedule, or otherwise, with reasonable promptness so as not to cause delay.

.04 The Contract Administrator's review shall be to check for conformity to the design concept and for general arrangement only and such review shall not relieve the Contractor of responsibility for errors or omissions in the Working Drawings or of responsibility for meeting all requirements of the Contract Documents, unless a deviation on the Working Drawings has been approved in writing by the Contract Administrator.

.05 The Contractor shall make any changes in Working Drawings that the Contract Administrator may require to make the Working Drawings consistent with the Contract Documents and resubmit, unless otherwise directed by the Contract Administrator. When resubmitting, the Contractor shall notify the Contract Administrator in writing of any revisions other than those requested by the Contract Administrator.

.06 Work related to the Working Drawings shall not proceed until the Working Drawings have been signed and dated by the Contract Administrator.

.07 The Contractor shall keep one set of the reviewed Working Drawings, marked as above, at the site at all times.

GC 3.03 Right of the Contract Administrator to Modify Methods and Equipment

.01 The Contractor shall, when requested in writing, make alterations in the method, Equipment, or work force at any time the Contract Administrator considers the Contractor's actions to be unsafe, or damaging to either the Work or existing facilities or the environment.

.02 The Contractor shall, when requested in writing, alter the sequence of its operations on the Contract so as to avoid interference with work being performed by others.

.03 Notwithstanding the foregoing, the Contractor shall ensure that all necessary safety precautions and protection are maintained throughout the Work.

GC 3.04 Emergency Situations

.01 The Contract Administrator has the right to determine the existence of an emergency situation and, when such an emergency situation is deemed to exist, the Contract Administrator may instruct the Contractor to take action to remedy the situation. If the Contractor does not take timely action or, if the Contractor is not available, the Contract Administrator may direct others to remedy the situation.

.02 If the emergency situation was the fault of the Contractor, the remedial Work shall be done at the Contractor's expense. If the emergency situation was not the fault of the Contractor, the Owner shall pay for the remedial Work.

GC 3.05 Layout Information

.01 The Contract Administrator shall provide background information, including without limitation, baseline and benchmark information, to facilitate the general location, alignment, elevation and layout of the Work.

.02 The Contract Administrator shall provide pre and post construction inventories of all Monuments, etc. that are located within the Working Area.

.03 The Owner shall be responsible only for the correctness of the layout information provided by the Contract Administrator.

GC 3.06 Extension of Contract Time

.01 An application for an extension of Contract Time shall be made in writing by the Contractor to the Contract Administrator as soon as the need for such extension becomes evident and at least 15 Days prior to the expiration of the Contract Time. The application for an extension of Contract Time shall enumerate the reasons and state the length of extension required.

.02 Circumstances suitable for consideration of an extension of Contract Time include the following:

a) Delays, subsection GC 3.07.

b) Changes in the Work, clause GC 3.10.01.

c) Extra Work, clause GC 3.10.02.

d) Additional Work, clause GC 3.10.03.

.03 The Contract Administrator shall, in reviewing an application for an extension to the Contract Time, consider whether the delays, Changes in the Work, Extra Work, or Additional Work involve a Controlling Operation.

.04 The Contract Time shall be extended for such additional time as may be recommended by the Contract Administrator and deemed fair and reasonable by the Owner.

.05 The terms and conditions of the Contract shall continue for such extension of Contract Time.

GC 3.07 Delays

.01 If the Contractor is delayed in the performance of the Work by,

a) war, blockades, and civil commotions;

b) errors in the Contract Documents;

c) an act or omission of the Owner or Contract Administrator, or anyone employed or engaged by them directly or indirectly, contrary to the provisions of the Contract Documents;

d) a stop work order issued by a court or public authority, provided that such order was not issued as the result of an act or omission of the Contractor or anyone employed or engaged by the Contractor directly or indirectly;

e) the Contract Administrator giving notice under section GC 7.0, Suspension of Work;

f) Abnormal Weather; or

g) archaeological finds, in accordance with subsection GC 3.15, Archaeological Finds,

then the Contractor shall be reimbursed by the Owner for reasonable costs incurred by the Contractor as the result of such delay, provided that in the case of an application for an extension of Contract Time due to Abnormal Weather, the Contractor shall, with the Contractor's application, submit evidence from Environment Canada in support of such application. Extension of Contract Time may be granted in accordance with subsection GC 3.06, Extension of Contract Time.

.02 If the Work is delayed by labour disputes, strikes or lock-outs, including lock-outs decreed or recommended to its members by a recognized contractor's association, of which the Contractor is a member or to which the Contractor is otherwise bound, which are beyond the Contractor's control, then the Contract Time shall be extended in accordance with subsection GC 3.06, Extension of Contract Time.

.03 In no case shall the extension of Contract Time be less than the time lost as the result of the event causing the delay, unless a shorter extension is agreed to by the Contractor. The Contractor shall not be entitled to payment for costs incurred as the result of such delays unless such delays are the result of actions by the Owner.

.04 The Contractor shall not be entitled to payment for the cost of delays incurred as a result of a dispute between the Contractor and Owner. The Contractor shall execute the Work and may pursue resolution of the dispute in accordance with subsection GC 3.13, Claims, Negotiations, Mediations.

GC 3.08 Assignment of Contract

.01 The Contractor shall not assign the Contract, either in whole or in part, without the prior written consent of the Owner.

GC 3.09 Subcontracting by the Contractor

.01 Subject to clause GC 3.09.03, Subcontracting by the Contractor, the Contractor may subcontract any part of the Work, in accordance with the Contract Documents and any limitations specified therein.

.02 The Contractor shall notify the Contract Administrator in writing in 10 Days prior to the start of construction of the intention to subcontract. Such notification shall identify the part of the Work, and the Subcontractor with whom it is intended.

.03 The Contract Administrator shall, within 5 Days of receipt of such notification, accept or reject the intended Subcontractor. The rejection shall be in writing and shall include the reasons for the rejection.

.04 The Contractor shall not, without the written consent of the Owner, change a Subcontractor who has been engaged in accordance with this subsection.

.05 The Contractor shall preserve and protect the rights of the Owner under the Contract Documents with respect to that part of the Work to be performed under subcontract and shall,

a) enter into agreements with the intended Subcontractors to require them to perform their Work in accordance with the Contract Documents; and

b) be as fully responsible to the Owner for acts and omissions of the Contractor's Subcontractors and of persons directly or indirectly employed by them as for acts and omissions of persons directly employed by the Contractor.

.06 The Owner's consent to subcontracting by the Contractor shall not be construed to relieve the Contractor from any obligation under the Contract and shall not impose any liability upon the Owner. Nothing contained in the Contract Documents shall create a contractual relationship between a Subcontractor and the Owner.

GC 3.10 Changes

GC 3.10.01 Changes in the Work

.01 The Owner, or the Contract Administrator where so authorized, may, by order in writing, make a Change in the Work without invalidating the Contract. The Contractor shall not be required to proceed with a Change in the Work until in receipt of a Change Order or Change Directive. Upon the receipt of such Change Order or Change Directive the Contractor shall proceed with the Change in the Work.

.02 The Contractor may apply for an extension of Contract Time according to the terms of clause GC 3.06, Extension of Contract Time.

.03 If the Change in the Work relates solely to quantities, payment for that part of the Work shall be made according to the conditions specified in clause GC 8.01.02, Variations in Tender Quantities. If the Change in the Work does not solely relate to quantities, then either the Owner or the Contractor may initiate negotiations upwards or downwards for the adjustment of the Contract price in respect of the Change in the Work pursuant to subsection GC 3.13, Claims, Negotiations, Mediation or payment may be made according to the conditions contained in clause GC 8.02.05, Payment on a Time and Material Basis.

GC 3.10.02 Extra Work

.01 The Owner, or Contract Administrator where so authorized, may instruct the Contractor to perform Extra Work without invalidating the Contract. The Contractor shall not be required to proceed with the Extra Work until in receipt of a Change Order or Change Directive. Upon receipt of such Change Order or Change Directive the Contractor shall proceed with the Extra Work.

.02 The Contractor may apply for an extension of Contract Time according to the terms of clause GC 3.06, Extension of Contract Time.

.03 Either the Owner or Contractor may initiate negotiations upwards or downwards for the payment for the Extra Work pursuant to subsection GC 3.13, Claims, Negotiations, Mediation, or payment may be made according to the conditions contained in clause GC 8.02.05, Payment on a Time and Material Basis.

GC 3.10.03 Additional Work

.01 The Owner, or Contract Administrator where so authorized, may request the Contractor to perform Additional Work without invalidating the Contract. If the Contractor agrees to perform Additional Work, the Contractor shall proceed with such Additional Work upon receipt of a Change Order.

.02 The Contractor may apply for an extension of Contract Time according to the terms of subsection GC 3.06, Extension of Contract Time.

.03 Payment for the Additional Work may be negotiated pursuant to subsection GC 3.13, Claims, Negotiations, Mediation, or payment may be made according to the conditions contained in clause GC 8.02.05, Payment on a Time and Material Basis.

GC 3.11 Notices

.01 Any notice permitted or required to be given to the Contract Administrator or the Superintendent in respect of the Work shall be deemed to have been given to and received by the addressee on the date of delivery if delivered by hand, email, or by facsimile transmission and on the fifth Day after the date of mailing, if sent by mail.

.02 The Contractor and the Owner shall provide each other with the mail and email addresses; cell phone, and telephone numbers for the Contract Administrator and the Superintendent at the commencement of the Work, and update as necessary.

.03 In the event of an emergency situation or other urgent matter the Contract Administrator or the Superintendent may give a verbal notice, provided that such notice is confirmed in writing within 2 Days.

.04 Any notice permitted or required to be given to the Owner or the Contractor shall be given in accordance with the notice provision of the Contract.

GC 3.12 Use and Occupancy of the Work Prior to Substantial Performance

.01 Where it is not contemplated elsewhere in the Contract Documents, the Owner may use or occupy the Work or any part thereof prior to Substantial Performance, provided that at least 30 Days written notice has been given to the Contractor.

.02 The use or occupancy of the Work or any part thereof by the Owner prior to Substantial Performance shall not constitute an acceptance of the Work or parts so occupied. In addition, the use or occupancy of the Work shall not relieve the Contractor or the Contractor's Surety from any liability that has arisen, or may arise, from the performance of the Work in accordance with the Contract Documents. The Owner shall be responsible for any damage that occurs because of the Owner's use or occupancy. Such use or occupancy of any part of the Work by the Owner does not waive the Owner's right to charge the Contractor liquidated damages in accordance with the terms of the Contract.

GC 3.13 Claims, Negotiations, Mediation

GC 3.13.01 Continuance of the Work

.01 Unless the Contract has been terminated or completed, the Contractor shall in every case, after serving or receiving any notification of a claim or dispute, verbal or written, continue to proceed with the Work with due diligence and expedition. It is understood by the parties that such action shall not jeopardize any claim it may have.

GC 3.13.02 Record Keeping

.01 Immediately upon commencing Work that may result in a claim, the Contractor shall keep Daily Work Records during the course of the Work, sufficient to substantiate the Contractor's claim, and the Contract Administrator shall keep Daily Work Records to be used in assessing the Contractor's claim, all in accordance with clause GC 8.02.07, Records.

.02 The Contractor and the Contract Administrator shall attempt to reconcile their respective Daily Work Records on a daily basis, to simplify review of the claim, when submitted. If the Contractor and the Contract Administrator fail to reconcile their respective Daily Work Records, then the Contractor shall submit its Daily Work Records as part of its claim, whereby the resolution of the dispute about the Daily Work Records shall not be resolved until there is a resolution of the claim.

.03 The keeping of Daily Work Records by the Contract Administrator or the reconciling of such Daily Work Records with those of the Contractor shall not be construed to be acceptance of the claim.

GC 3.13.03 Claims Procedure

.01 The Contractor shall give verbal notice of any situation that may lead to a claim for additional payment immediately upon becoming aware of the situation.

.02 The Contractor shall provide written notice within 7 Days of the commencement of any part of the Work that may be affected by the situation.

.03 The Contractor shall submit detailed claims as soon as reasonably possible and in any event no later than 30 Days or such time as mutually agreed after completion of the Work affected by the situation. The detailed claim shall:

a) identify the item or items in respect of which the claim arises;

b) state the grounds, contractual or otherwise, upon which the claim is made; and

c) include the Records maintained by the Contractor supporting such claim.

.04 Within 30 Days of the receipt of the Contractor's detailed claim, the Contract Administrator may request the Contractor to submit any further and other particulars as the Contract Administrator considers necessary to assess the claim. The Contractor shall submit the requested information within 30 Days of receipt of such request.

.05 Within 90 Days of receipt of the detailed claim, the Contract Administrator shall advise the Contractor, in writing, of the Contract Administrator's opinion regarding the validity of the claim.

GC 3.13.04 Negotiations

.01 The parties shall make all reasonable efforts to resolve their dispute by amicable negotiations and agree to provide, without prejudice, open and timely disclosure of relevant facts, information, and documents to facilitate these negotiations.

.02 Should the Contractor disagree with the opinion given in clause GC 3.13.03.05, with respect to any part of the claim, the Contract Administrator shall enter into negotiations with the Contractor to resolve the matters in dispute. Where a negotiated settlement cannot be reached and it is agreed that payment cannot be made on a Time and Material basis in accordance with clause GC 8.02.05, Payment on a Time and Material Basis, the parties shall proceed in accordance with clause GC 3.13.05, Mediation, or subsection GC 3.14, Arbitration.

.03 Prior to the expiry of 30 Business Days from the date of receipt of the Contractors claim, the Contract Administrator shall provide a written response to the Contractor stating the Contract Administrator’s final price for the Change Order and an explanation of the rationale and basis of the Contract Administrator’s position which shall be deemed to be the initial site response.

GC 3.13.05 Mediation

.01 If a claim is not resolved satisfactorily through the negotiation stage noted in clause GC 3.13.04, Negotiations, within a period of 30 Days following the opinion given in clause GC 3.13.03.05, and the Contractor wishes to pursue the issue further, the parties may, upon mutual agreement, utilize the services of an independent third-party mediator.

.02 The mediator shall be mutually agreed upon by the Owner and Contractor.

.03 The mediator shall be knowledgeable regarding the area of the disputed issue. The mediator shall meet with the parties together or separately, as necessary, to review all aspects of the issue. In a final attempt to assist the parties in resolving the issue themselves prior to proceeding to arbitration the mediator shall provide, without prejudice, a non-binding recommendation for settlement.

.04 The review by the mediator shall be completed within 90 Days following the opinion given in clause GC 3.13.03.05.

.05 Each party is responsible for its own costs related to the use of the mediation process. The cost of the third-party mediator shall be equally shared by the Owner and Contractor.

GC 3.13.06 Payment

.01 Payment of the claim shall be made no later than 28 Days after the date of resolution of the claim or dispute. Such payment shall be made according to the terms of section GC 8.0, Measurement and Payment.

GC 3.13.07 Rights of Both Parties

.01 It is agreed that no action taken under subsection GC 3.13, Claims, Negotiations, Mediation, by either party shall be construed as a renunciation or waiver of any of the rights or recourse available to the parties, provided that the requirements set out in this subsection are fulfilled.

.02 It is further agreed that the parties may at any time resort to the adjudication procedure contained in the Construction Act.

GC 3.14 Arbitration

GC 3.14.01 Conditions of Arbitration

.01 If a claim is not resolved satisfactorily through the negotiation stage noted in clause GC 3.13.04, Negotiations, or the mediation stage noted in clause GC 3.13.05, Mediation, either party may invoke the provisions of subsection GC 3.14, Arbitration, by giving written notice to the other party.

.02 Notification that arbitration shall be implemented to resolve the issue shall be communicated in writing as soon as possible and no later than 60 Days following the opinion given in clause GC 3.13.03.05. Where the use of a third-party mediator was implemented, notification shall be within 120 Days of the opinion given in clause GC 3.13.03.05.

.03 The parties shall be bound by the decision of the arbitrator.

.04 The rules and procedures of the Arbitration Act, 1991, S.O. 1991, c.17, as amended, shall apply to any arbitration conducted hereunder except to the extent that they are modified by the express provisions of subsection GC 3.14, Arbitration.

GC 3.14.02 Arbitration Procedure

.01 The following provisions are to be included in the agreement to arbitrate and are subject only to such right of appeal as exist where the arbitrator has exceeded his or her jurisdiction or have otherwise disqualified him or herself:

a) All existing actions in respect of the matters under arbitration shall be stayed pending arbitration;

b) All outstanding claims and matters to be settled are to be set out in a schedule to the agreement. Only such claims and matters as are in the schedule shall be arbitrated; and

c) Before proceeding with the arbitration, the Contractor shall confirm that all matters in dispute are set out in the schedule.

GC 3.14.03 Appointment of Arbitrator

.01 The arbitrator shall be mutually agreed upon by the Owner and Contractor to adjudicate the dispute.

.02 Where the Owner and Contractor cannot agree on a sole arbitrator within 30 Days of the notification of arbitration noted in clause GC 3.14.01.02, the Owner and the Contractor shall each choose an appointee within 37 Days of the notice of arbitration.

.03 The appointees shall mutually agree upon an arbitrator to adjudicate the dispute within 15 Days after the last appointee was chosen or they shall refer the matter to the ADR Institute of Ontario (ADRIO), which may select an arbitrator to adjudicate the dispute within 7 Days of being requested to do so.

.04 The arbitrator shall not be interested financially in the Contract nor in either party's business and shall not be employed by either party.

.05 The arbitrator may appoint independent experts and any other persons to assist him or her.

.06 The arbitrator is not bound by the rules of evidence that govern the trial of cases in court but may hear and consider any evidence that the arbitrator considers relevant.

.07 The hearing shall commence within 90 Days of the appointment of the arbitrator.

GC 3.14.04 Costs

.01 The arbitrator's fee shall be equally shared by the Owner and the Contractor.

.02 The fees of any independent experts and any other persons appointed to assist the arbitrator shall be shared equally by the Owner and the Contractor.

.03 The arbitration hearing shall be held in a place mutually agreed upon by both parties or in the event the parties do not agree, a site shall be chosen by the arbitrator. The cost of obtaining appropriate facilities shall be shared equally by the Owner and the Contractor.

.04 The arbitrator may, in his or her discretion, award reasonable costs, related to the arbitration.

GC 3.14.05 The Decision

.01 The reasoned decision shall be made in writing within 90 Days of the conclusion of the hearing. An extension of time to make a decision may be granted with consent of both parties. Payment shall be made in accordance with clause GC 3.13.06, Payment.

GC 3.15 Archaeological Finds

.01 If the Contractor's operations expose any items that may indicate an archaeological find, such as but not limited to building remains, hardware, accumulations of bones, pottery, or arrowheads, the Contractor shall immediately notify the Contract Administrator and suspend operations within the area identified by the Contract Administrator. Notification may be verbal provided that such notice is confirmed in writing within 2 Days. Work shall remain suspended within that area until otherwise directed by the Contract Administrator in writing, in accordance with subsection GC 7.09, Suspension of Work.

.02 Any delay in the completion of the Contract that is caused by such a suspension of Work shall be considered to be beyond the Contractor's control in accordance with clause GC 3.07.01.

.03 Any Work directed or authorized in connection with an archaeological find shall be considered as Extra Work in accordance with clause GC 3.10.02, Extra Work.

.04 The Contractor shall take all reasonable action to minimize additional costs that may accrue as a result of any work stoppage.

SECTION GC 4.0 - OWNER'S RESPONSIBILITIES AND RIGHTS

GC 4.01 Working Area

.01 The Owner shall acquire all property rights that are deemed necessary by the Owner for the construction of the Work, including temporary working easements, and shall indicate the full extent of the Working Area on the Contract Drawings.

GC 4.02 Approvals and Permits

.01 The Owner shall pay for all plumbing and building permits.

.02 The Owner shall obtain and pay for all permits, licences, and certificates solely required for the design of the Work.

GC 4.03 Management and Disposition of Materials

.01 The Owner shall identify in the Contract Documents the Materials to be moved within or removed from the Working Area and any characteristics of those Materials that necessitates special Materials management and disposition.

.02 In accordance with regulations under the Occupational Health and Safety Act, R.S.O. 1990, c.O.1, as amended, the Owner advises that,

a) the designated substances silica, lead, and arsenic are generally present throughout the Working Area occurring naturally or as a result of vehicle emissions;

b) the designated substance asbestos may be present in cement products, asphalt, and conduits for Utilities;

c) the following hazardous materials are ordinarily present in construction activities: limestone, gypsum, marble, mica, and Portland cement; and

d) exposure to these substances may occur as a result of activities by the Contractor such as sweeping, grinding, crushing, drilling, blasting, cutting, and abrasive blasting.

.03 The Owner shall identify in the Contract Documents any designated substances or hazardous materials other than those identified above and their location in the Working Area.

.04 If the Owner or Contractor discovers or is advised of the presence of designated substances or hazardous Materials that are in addition to those listed in clause GC 4.03.02, or not clearly identified in the Contract Documents according to clause GC 4.03.03, then verbal notice shall be provided to the other party immediately with written confirmation within 2 Days. The Contractor shall stop Work in the area immediately and shall determine the necessary steps required to complete the Work in accordance with applicable legislation and regulations.

.05 The Owner shall be responsible for any reasonable additional costs of removing, managing and disposing of any Material not identified in the Contract Documents, or where conditions exist that could not have been reasonably foreseen at the time of tendering. All work under this paragraph shall be deemed to be Extra Work.

.06 Prior to commencement of the Work, the Owner shall provide to the Contractor a list of those products controlled under the Workplace Hazardous Materials Information System (WHMIS), that the Owner may supply or use on the Contract, together with copies of the Safety Data Sheets for these products. All containers used in the application of products controlled under WHMIS shall be labelled. The Owner shall notify the Contractor in writing of changes to the list and provide relevant Safety Data Sheets.

.07 Unless expressly permitted in the Contract Documents, the Contractor shall not bring onto the Work Area any designated substance or hazardous Material per OHSA without the prior written authorization of the Contract Administrator.

.08 The Contractor shall use all reasonable care to avoid spilling or disturbing any designated substances or hazardous Material per OHSA.

GC 4.04 Construction Affecting Railway Property

.01 The Owner shall pay the costs of all flagging and other traffic control measures required and provided by the railway company unless such costs are solely a function of the Contractor's chosen method of completing the Work.

.02 Every precaution shall be taken by the Contractor to protect all railway property at track crossings; or otherwise, on which construction operations are to take place in accordance with the terms of this Contract.

.03 The Contractor shall be required to conduct the construction operations in such a manner as to avoid a possibility of damaging any railway property in the vicinity of the Works. Every reasonable precaution shall be taken by the Contractor to ensure the safety of the workers, Subcontractors, and Equipment, as well as railway property throughout the duration of the Contract.

GC 4.05 Default by the Contractor

.01 If the Contractor fails to commence the Work within 14 Days of a formal order to commence Work signed by the Contract Administrator or, upon commencement of the Work, should neglect to prosecute the Work properly or otherwise fails to comply with the requirements of the Contract and, if the Contract Administrator has given a written statement to the Owner and Contractor that sufficient cause exists to justify such action, the Owner may, without prejudice to any other right or remedy the Owner may have, notify the Contractor in writing that the Contractor is in default of the Contractor’s contractual obligations and instruct the Contractor to correct the default in the 5 Working Days immediately following the receipt of such notice.

.02 If the Contractor is adjudged bankrupt, or makes a general assignment for the benefit of creditors because of the Contractor’s insolvency or if a receiver is appointed because of the Contractor’s insolvency, the Owner may, without prejudice to any other right or remedy the Owner may have, by giving the Contractor or receiver or trustee in bankruptcy notice in writing, terminate the Contract.

GC 4.06 Contractor's Right to Correct a Default

.01 The Contractor shall have the right within the 5 Working Days following the receipt of a notice of default to correct the default and provide the Owner with satisfactory proof that appropriate corrective measures have been taken.

.02 If the Owner determines that the correction of the default cannot be completed within the 5 Working Days following receipt of the notice, the Contractor shall not be in default if the Contractor,

a) commences the correction of the default within the 5 Working Days following receipt of the notice;

b) provides the Owner with a schedule acceptable to the Owner for the progress of such correction; and

c) completes the correction in accordance with such schedule.

GC 4.07 Owner's Right to Correct Default

.01 If the Contractor fails to correct the default within the time specified in subsection GC 4.06, Contractor's Right to Correct a Default, or subsequently agreed upon, the Owner, without prejudice to any other right or remedy the Owner may have, may correct such default and deduct the cost thereof, as certified by the Contract Administrator, from any payment then or thereafter due to the Contractor.

GC 4.08 Termination of Contractor's Right to Continue the Work

.01 Where the Contractor fails to correct a default within the time specified in subsection GC 4.06, Contractor's Right to Correct a Default, or subsequently agreed upon, the Owner, without prejudice to any other right or remedy the Owner may have, may terminate the Contractor's right to continue the Work in whole or in part by giving written notice to the Contractor.

.02 If the Owner terminates the Contractor's right to continue with the Work in whole or in part, the Owner shall be entitled to,

a) take possession of the Working Area or that portion of the Working Area devoted to that part of the Work terminated;

b) utilize any Material within the Working Area;

d) withhold further payments to the Contractor with respect to the Work or the portion of the Work withdrawn from the Contractor until the Work or portion thereof withdrawn is completed;

d) charge the Contractor the additional cost over the Contract price of completing the Work or portion thereof withdrawn from the Contractor, as certified by the Contract Administrator and any additional compensation paid to the Contract Administrator for such additional service arising from the correction of the default;

e) charge the Contractor a reasonable allowance, as determined by the Contract Administrator, to cover correction to the Work performed by the Contractor that may be required under subsection GC 7.16, Warranty;

f) charge the Contractor for any damages the Owner sustained as a result of the default; and

g) charge the Contractor the amount by which the cost of corrections to the Work under subsection GC 7.16, Warranty, exceeds the allowance provided for such corrections.

GC 4.09 Final Payment to Contractor

.01 If the Owner's cost to correct and complete the Work in whole or in part is less than the amount withheld from the Contractor under subsection GC 4.08, Termination of Contractor's Right to Continue the Work, the Owner shall pay the balance to the Contractor as soon as the final accounting for the Contract is complete.

GC 4.10 Termination of the Contract

.01 Where the Contractor is in default of the Contract the Owner shall, without prejudice to any other right or remedy the Owner may have, terminate the Contract by giving written notice of termination to the Contractor, the Surety, and any trustee or receiver acting on behalf of the Contractor's estate or creditors.

.02 If the Owner elects to terminate the Contract, the Owner shall provide the Contractor and the trustee or receiver with a complete accounting to the date of termination.

GC 4.11 Continuation of Contractor's Obligations

.01 The Contractor's obligation under the Contract as to quality, correction, and warranty of the Work performed prior to the time of termination of the Contract or termination of the Contractor's right to continue with the Work in whole or in part shall continue to be in force after such termination.

GC 4.12 Use of Performance Bond

.01 If the Contractor is in default of the Contract and the Contractor has provided a Performance Bond, the provisions of section GC 4.0, Owner’s Responsibilities and Rights, shall be exercised in accordance with the conditions of the Performance Bond.

GC 4.13 Payment Adjustment

.01 If any situation should occur in the performance of the Work that would result in a Change in the Work, the Owner shall be entitled to an adjustment and those adjustments shall be managed in accordance with clause GC 3.10.01, Changes in the Work.

SECTION GC 5.0 - MATERIAL

GC 5.01 Supply of Material

.01 All Material necessary for the proper completion of the Work, except that listed as being supplied by the Owner, shall be supplied by the Contractor. The Contract price for the appropriate tender items shall be deemed to include full compensation for the supply and delivery of such Material.

GC 5.02 Quality of Material

.01 All Material supplied by the Contractor shall be new, unless otherwise specified in the Contract Documents.

.02 Material supplied by the Contractor shall conform to the requirements of the Contract.

.03 As specified in the Contract Documents or as requested by the Contract Administrator, the Contractor shall make available, for inspection or testing, a sample of any Material to be supplied by the Contractor.

.04 The Contractor shall obtain for the Contract Administrator the right to enter onto the premises of the Material manufacturer or supplier to carry out such inspection, sampling, and testing as specified in the Contract Documents or as requested by the Contract Administrator.

.05 The Contractor shall notify the Contract Administrator of the sources of supply sufficiently in advance of the Material shipping dates to enable the Contract Administrator to perform the required inspection, sampling, and testing.

.06 The Owner shall not be responsible for any delays to the Contractor's operations where the Contractor fails to give sufficient advance notice to the Contract Administrator to enable the Contract Administrator to carry out the required inspection, sampling, and testing before the scheduled shipping date.

.07 The Contractor shall not change the source of supply of any Material without the written authorization of the Contract Administrator.

.08 Material that is not specified shall be of a quality best suited to the purpose required, and the use of such Material shall be subject to the approval of the Contract Administrator.

.09 All Material inspection, sampling, and testing shall be carried out on random basis in accordance with the standard inspection or testing methods required for the Material. Any approval given by the Contract Administrator for the Materials to be used in the Work based upon the random method shall not relieve the Contractor from the responsibility of incorporating Material that conforms to the Contract Documents into the Work or properly performing the Contract and of any liability arising from the failure to properly perform as specified in the Contract Documents.

GC 5.03 Rejected Material

.01 Rejected Material shall be removed from the Working Area expeditiously after the notification to that effect from the Contract Administrator. Where the Contractor fails to comply with such notice, the Contract Administrator may cause the rejected Material to be removed from the Working Area and disposed of, in what the Contract Administrator considers to be the most appropriate manner, and the Contractor shall pay the costs of disposal and the appropriate overhead charges.

GC 5.04 Substitutions

.01 Where the Contract Documents require the Contractor to supply a Material designated by a trade or other name, the Tender shall be based only upon supply of the Material so designated, that shall be regarded as the standard of quality required by the Contract Documents. After the acceptance of the Tender, the Contractor may apply to the Contract Administrator to substitute another Material identified by a different trade or other name for the Material designated as aforesaid. The application shall be in writing and shall state the price for the proposed substitute Material designated as aforesaid, and such other information as the Contract Administrator may require.

.02 Rulings on a proposed substitution shall not be made prior to the acceptance of the Tender. Substitutions shall not be made without the prior approval of the Contract Administrator. The approval or rejection of a proposed substitution shall be at the discretion of the Contract Administrator.

.03 If the proposed substitution is approved by the Contract Administrator, the Contractor shall be entitled to the first $1,000 of the aggregate saving in cost by reason of such substitution and to 50% of any additional saving in cost in excess of such $1,000. Each such approval shall be conveyed to the Contractor in writing or by issuance of a Certificate of Equality on the Owner's standard form of "Certification of Equality" and, if any adjustment to the Contract price is made by reason of such substitution, a Change Order shall be issued as well.

GC 5.05 Owner Supplied Material

GC 5.05.01 Ordering of Excess Material

.01 Where Material is supplied by the Owner and where this Material is ordered by the Contractor in excess of the amount specified to complete the Work, such excess Material shall become the property of the Contractor on completion of the Work and shall be charged to the Contractor at cost plus applicable overheads.

GC 5.05.02 Care of Material

.01 The Contractor shall, in advance of receipt of shipments of Material supplied by the Owner, provide adequate and proper storage facilities acceptable to the Contract Administrator, and on the receipt of such Material shall promptly place it in storage, except where it is to be incorporated forthwith into the Work.

.02 The Contractor shall be responsible for acceptance of Material supplied by the Owner, at the specified delivery point and for its safe handling and storage. If such Material is damaged while under the control of the Contractor, it shall be replaced or repaired by the Contractor at no expense to the Owner, and to the satisfaction of the Contract Administrator. If such Material is rejected by the Contract Administrator for reasons that are not the fault of the Contractor, it shall remain in the care and at the risk of the Contractor until its disposition has been determined by the Contract Administrator.

.03 Where Material supplied by the Owner arrives at the delivery point in a damaged condition or where there are discrepancies between the quantities received and the quantities shown on the bills of lading, the Contractor shall immediately report such damage or discrepancies to the Contract Administrator who shall arrange for an immediate inspection of the shipment and provide the Contractor with a written release from responsibility for such damage or deficiencies. Where damage or deficiencies are not so reported, it shall be assumed that the shipment arrived in good condition and order, and any damage or deficiencies reported thereafter shall be made good by the Contractor at no extra cost to the Owner.

.04 The full amount of Material supplied by the Owner in each shipment shall be accounted for by the Contractor and such Material shall be at the risk of the Contractor after taking delivery. Such Material shall not, except with the written permission of the Contract Administrator, be used by the Contractor for purposes other than the performance of the Work under the Contract.

.05 Empty reels, crates, containers, and other type of packaging from Material supplied by the Owner shall become the property of the Contractor when they are no longer required for their original purpose and shall be disposed of by the Contractor at the Contractor's expense unless otherwise specified in the Contract Documents.

.06 Immediately upon receipt of each shipment, the Contractor shall provide the Contract Administrator copies of bills of lading, or such other documentation the Contract Administrator may require to substantiate and reconcile the quantities of Material received.

.07 Where Material supplied by the Owner is ordered and stockpiled prior to the award of the Contract, the Contractor shall, at no extra cost to the Owner, immediately upon commencement of operations, check the Material, report any damage or deficiencies to the Contract Administrator and take charge of the Material at the stockpile site. Where damage or deficiencies are not so recorded by the Contractor, it shall be assumed that the stockpile was in good condition and order when the Contractor took charge of it, and any damage or deficiencies reported thereafter shall be made good by the Contractor at no extra cost to the Owner.

SECTION GC 6.0 - INSURANCE, PROTECTION AND DAMAGE

GC 6.01 Protection of Work, Persons and Property

.01 The Contractor, the Contractor's agents, and all workers employed by or under the control of the Contractor, including Subcontractors, shall protect the Work, persons, and property from damage or injury. The Contractor shall be responsible for all losses and damage that may arise as the result of the Contractor's operations under the Contract, unless indicated to the contrary below.

.02 The Contractor is responsible for the full cost of any necessary temporary protective Work and the restoration of all damage where the Contractor damages the Work or property in the performance of the Contract. If the Contractor is not responsible for the damage that occurs to the Work or property, the Contractor shall restore such damage, and such Work and payment shall be administered according to these General Conditions.

.03 The Contractor shall immediately inform the Contract Administrator of all damage and injuries that occur during the term of the Contract. The Contractor shall then investigate and report back to the Contract Administrator within 15 Days of occurrence of incident, or as soon as possible. The Contract Administrator may conduct its own investigation and the Contractor shall provide all assistance to the Contract Administrator as may be necessary for that purpose.

.04 The Contractor shall not be responsible for loss and damage that occurs as a result of,

a) war;

b) blockades and civil commotions;

c) errors in the Contract Documents; or

d) acts or omissions of the Owner, the Contract Administrator, their agents and employees, or others not under the control of the Contractor, but within the Working Area with the Owner's permission.

.05 The Contractor and the Contractor’s Surety shall not be released from any term or provision of any responsibility, obligation, or liability under the Contract or waive or impair any of the rights of the Owner, except by a release duly executed by the Owner.

GC 6.02 Indemnification

.01 The Contractor shall indemnify and hold harmless the Owner and the Contract Administrator, their elected officials, agents, officers, and employees from and against all claims, demands, losses, expenses, costs, damages, actions, suits, or proceedings by third parties, hereinafter called "claims", directly or indirectly arising or alleged to arise out of the performance of or the failure to perform the Work, provided such claims are,

a) attributable to bodily injury, sickness, disease, or death or to damage to or destruction of tangible property;

b) caused by negligent acts or omissions of the Contractor or anyone for whose acts the Contractor may be liable; and

c) made in writing within a period of 6 years from the date of Substantial Performance of the Work as set out in the Certificate of Substantial Performance of the Work or, where so specified in the Contract Documents, from the date of certification of Final Acceptance.

.02 The Contractor shall indemnify and hold harmless the Owner from all and every claim for damages, royalties or fees for the infringement of any patented invention or copyright occasioned by the Contractor in connection with the Work performed or Material furnished by the Contractor under the Contract.

.03 The Owner expressly waives the right to indemnity for claims other than those stated in clauses GC 6.02.01 and GC 6.02.02.

.04 The Owner shall indemnify and hold harmless the Contractor, their elected officials, agents, officers, and employees from and against all claims, demands, losses, expenses, costs, damages, actions, suits, or proceedings arising out of the Contractor's performance of the Contract that are attributable to a lack of or defect in title or an alleged lack of or defect in title to the Working Area.

.05 The Contractor expressly waives the right to indemnity for claims other than those stated in clause GC 6.02.04.

GC 6.03 Contractor's Insurance

GC 6.03.01 General

.01 Without restricting the generality of subsection GC 6.02, Indemnification, the Contractor shall provide, maintain, and pay for the insurance coverages listed under clauses GC 6.03.02 and GC 6.03.03. Insurance coverage in clauses GC 6.03.04, GC 6.03.05, and GC 6.03.06 shall only apply when so specified in the Contract Documents.

.02 The Contractor shall provide the Contract Administrator with an original Certificate of Insurance for each type of insurance coverage that is required by the Contract Documents. The Contractor shall ensure that the Contract Administrator is, at all times in receipt of a valid Certificate of Insurance for each type of insurance coverage, in such amounts as specified in the Contract Documents. The Contractor will not be permitted to commence Work until the Contract Administrator is in receipt of such proof of insurance. The Contract Administrator may withhold payments of monies due to the Contractor until the Contractor has provided the Contract Administrator with original valid Certificates of Insurance as required by the provisions of the Contract Documents.

GC 6.03.02 Commercial General Liability Insurance

.01 Commercial General Liability Insurance shall be in the name of the Contractor, with the Owner and the Contract Administrator named as additional insureds, with limits of not less than five million dollars inclusive per occurrence for bodily injury, death, and damage to property including loss of use thereof. The insurance shall be provided in a form acceptable to the Owner.

.02 Approval of this insurance shall be conditional upon the Contractor obtaining the services of an insurer licensed to underwrite insurance in the Province of Ontario and obtaining the insurer's certificate of equivalency to the required insurance.

.03 The Contractor shall submit annually to the Owner, proof of continuation of the completed operations coverage and, if the Contractor fails to do so, the limitation period for claiming indemnity described in clause GC 6.02.01 c), shall not be binding on the Owner.

.04 Should the Contractor decide not to employ Subcontractors for operations requiring the use of explosives for blasting, pile driving or caisson work, removal or weakening of support of property building or land, the Commercial General Liability Insurance shall include the appropriate endorsements.

.05 The policies shall be endorsed to provide the Owner with not less than 30 Days written notice in advance of cancellation, termination, or material change.

.06 "Claims Made" insurance policies shall not be permitted.

GC 6.03.03 Automobile Liability Insurance

.01 Automobile liability insurance in respect of licensed vehicles shall have limits of not less than five million dollars inclusive per occurrence for bodily injury, death and damage to property, in the following forms endorsed to provide the Owner with not less than 30 Days written notice in advance of any cancellation, termination, or material change.

a) standard non-owned automobile policy including standard contractual liability endorsement, and

b) standard owner's form automobile policy providing third party liability and accident benefits insurance and covering licensed vehicles owned or operated by the Contractor.

GC 6.03.04 Aircraft and Watercraft Liability Insurance

GC 6.03.04.01 Aircraft Liability Insurance

.01 Aircraft liability insurance with respect to owned or non-owned aircraft used directly or indirectly in the performance of the Work, including use of additional premises, shall be subject to limits of not less than five million dollars inclusive per occurrence for bodily injury, death, and damage to property including loss of use thereof, and limits of not less than five million dollars for aircraft passenger hazard. Such insurance shall be in a form acceptable to the Owner. The policies shall be endorsed to provide the Owner with not less than 30 Days written notice in advance of cancellation, change, or amendment restricting coverage.

GC 6.03.04.02 Watercraft Liability Insurance

.01 Watercraft liability insurance with respect to owned or non-owned watercraft used directly or indirectly in the performance of the Work, including use of additional premises, shall be subject to limits of not less than five million dollars inclusive per occurrence for bodily injury, death, and damage to property including loss of use thereof. Such insurance shall be in a form acceptable to the Owner. The policies shall be endorsed to provide the Owner with not less than 30 Days written notice in advance of cancellation, change, or amendment restricting coverage.

GC 6.03.05 Property and Boiler Insurance

GC 6.03.05.01 Property Insurance

.01 All risks property insurance shall be in the name of the Contractor, with the Owner and the Contract Administrator named as additional insureds, insuring not less than the sum of the amount of the Contract price and the full value, as may be stated in the Contract Documents, of Material that is specified to be provided by the Owner for incorporation into the Work.

GC 6.03.05.02 Boiler Insurance

.01 Boiler insurance insuring the interests of the Contractor, the Owner and the Contract Administrator for not less than the replacement value of boilers and pressure vessels forming part of the Work, shall be in a form acceptable to the Owner.

GC 6.03.05.03 Use and Occupancy of the Work Prior to Completion

.01 Should the Owner wish to use or occupy part or all of the Work prior to Substantial Performance, the Owner shall give 30 Days written notice to the Contractor of the intended purpose and extent of such use or occupancy. Prior to such use or occupancy, the Contractor shall notify the Owner in writing of

the additional premium cost, if any, to maintain property and boiler insurance, which shall be at the Owner's expense. If because of such use or occupancy the Contractor is unable to provide coverage, the Owner upon written notice from the Contractor and prior to such use or occupancy shall provide, maintain, and pay for property and boiler insurance insuring the full value of the Work, including coverage for such use or occupancy, and shall provide the Contractor with proof of such insurance. The Contractor shall refund to the Owner the unearned premiums applicable to the Contractor's policies upon termination of coverage.

.02 The policies shall provide that in the event of a loss or damage, payment shall be made to the Owner and the Contractor as their respective interests may appear. The Contractor shall act on behalf of both the Owner and the Contractor for the purpose of adjusting the amount of such loss or damage payment with the insurers. When the extent of the loss or damage is determined, the Contractor shall proceed to restore the Work. Loss or damage shall not affect the rights and obligations of either party under the Contract, except that the Contractor shall be entitled to such reasonable extension of Contract Time relative to the extent of the loss or damage as the Contract Administrator may decide in consultation with the Contractor.

GC 6.03.05.04 Payment for Loss or Damage

.01 The Contractor shall be entitled to receive from the Owner, in addition to the amount due under the Contract, the amount at which the Owner's interest in restoration of the Work has been appraised, such amount to be paid as the restoration of the Work proceeds, and in accordance with the requirements of section GC 8.0, Measurement and Payment. In addition, the Contractor shall be entitled to receive from the payments made by the insurers the amount of the Contractor's interest in the restoration of the Work.

.02 The Contractor shall be responsible for deductible amounts under the policies, except where such amounts may be excluded from the Contractor's responsibility by the terms of this Contract.

.03 In the event of a loss or damage to the Work arising from the action or omission of the Owner or others, the Owner shall pay the Contractor the cost of restoring the Work as the restoration of the Work proceeds and in accordance with the requirements of section GC 8.0, Measurement and Payment.

GC 6.03.06 Contractor's Equipment Insurance

.01 All risks Contractor's Equipment insurance covering construction equipment used by the Contractor for the performance of the Work, including boiler insurance on temporary boilers and pressure vessels, shall be in a form acceptable to the Owner and shall not allow subrogation claims by the insurer against the Owner. The policies shall be endorsed to provide the Owner with not less than 30 Days written notice in advance of cancellation, change, or amendment restricting coverage. Subject to satisfactory proof of financial capability by the Contractor for self-insurance of the Contractor's Equipment, the Owner agrees to waive the equipment insurance requirement, and for the purpose of this Contract, the Contractor shall be deemed to be insured. This policy shall be amended to provide permission for the Contractor to grant prior releases with respect to damage to the Contractor's Equipment.

GC 6.03.07 Insurance Requirements and Duration

.01 Each insurance policy as noted in the Contract Documents shall be in effect from the date of commencement of the Work until 10 Days after the date of Final Acceptance of the Work, as set out in the Final Acceptance Certificate.

.02 The Contractor shall provide the Owner, on a form acceptable to the Owner, proof of insurance prior to commencement of the Work and signed by the underwriter or the broker.

.03 The Contractor shall, on request, promptly provide the Owner with a certified true copy of each insurance policy exclusive of information pertaining to premium or premium bases used by the insurer to determine the cost of the insurance. The certified true copy shall include the signature of an officer of the insurer.

.04 Where a policy is renewed, the Contractor shall provide the Owner, on a form acceptable to the Owner, renewed proof of insurance immediately following completion of renewal.

.05 Unless specified otherwise, the Contractor shall be responsible for the payment of deductible amounts under the policies.

.06 If the Contractor fails to provide or maintain insurance as required in subsection GC 6.03, Contractor's Insurance, or elsewhere in the Contract Documents, then the Owner shall have the right to provide and maintain such insurance and give evidence thereof to the Contractor. The Owner's cost thereof shall be payable by the Contractor to the Owner on demand.

.07 If the Contractor fails to pay the cost of the insurance placed by the Owner within 28 Days of the date on which the Owner made a formal demand for reimbursement of such costs, the Owner may deduct the costs thereof from monies which are due or may become due to the Contractor.

GC 6.04 Bonding

.01 The Contractor shall provide the Owner with the surety bonds in the amount required by the Contract Documents.

.02 Such bonds shall be issued by a duly licensed surety company authorized to transact a business of suretyship in the Province of Ontario and shall be to the satisfaction of the Owner. The bonds shall be maintained in good standing until the Final Acceptance.

GC 6.05 Workplace Safety and Insurance Board

.01 The Contractor shall provide the Contract Administrator with a copy of a Certificate of Clearance indicating the Contractor’s good standing with the Workplace Safety and Insurance Board, as follows:

a) Immediately prior to the Contract Administrator authorizing the Contractor to commence Work.

b) Prior to issue of the Certificate of Substantial Performance.

c) Prior to expiration of the Warranty Period.

d) At any other time when requested by the Contract Administrator.

SECTION GC 7.0 - CONTRACTOR'S RESPONSIBILITIES AND CONTROL OF THE WORK

GC 7.01 General

GC 7.01.01 Site Visit

.01 The Contractor warrants that the site of the Work has been visited during the preparation of the Tender and the character of the Work and all local conditions that may affect the performance of the Work are known.

GC 7.01.02 Commencement of Work

.01 The Contractor shall not commence the Work nor deliver anything to the Working Area until the Contractor has received a written order to commence the work from the Contract Administrator.

GC 7.01.03 Control and Responsibility

.01 The Contractor shall have complete control of the Work and shall effectively direct and supervise the Work so as to ensure conformity with the Contract Documents. The Contractor shall be responsible for construction means, methods, techniques, sequences, and procedures and for coordinating the various parts of the Work.

.02 The Contractor shall provide adequate labour, Equipment, and Material to ensure the completion of the Contract in accordance with the Contract Documents. The Work shall be performed as vigorously and as continuously as weather conditions or other interferences may permit.

.03 The Contractor shall have the sole responsibility for the design, erection, operation, maintenance, and removal of temporary structures and other temporary facilities and the design and execution of construction methods required in their use.

.04 Notwithstanding clause GC 7.01.03, where the Contract Documents include designs for temporary structures and other temporary facilities or specify a method of construction in whole or part, such facilities and methods shall be considered to be part of the design of the Work, and the Contractor shall not be held responsible for that part of the design or the specified method of construction. The Contractor shall, however, be responsible for the execution of such design or specified method of construction in the same manner that the Contractor is responsible for the execution of the Work.

.05 The Contractor shall comply with and conform to all statutes, laws, by-laws, regulations, requirements, ordinances, notices, rulings, orders, directives and policies of the municipal, provincial and federal governments and any other lawful authority and all court orders, judgments and declarations of a court of competent jurisdiction (collectively referred to as the “Laws”), applicable to the Work to be provided by, and the undertakings and obligations of, the Contractor under this Contract.

GC 7.01.04 Compliance with the Occupational Health and Safety Act

.01 The Contractor shall execute the terms of the Contract in strict compliance with the requirements of the Occupational Health and Safety Act, R.S.O. 1990, c.O.1, as amended, (the "Act") and Ontario Regulation 213/91, as amended, (that regulates Construction Projects) and any other regulations as amended under the Act (the "Regulations") that may affect the performance of the Work, as the "Constructor" or "employer," as defined by the Act, as the case may be. The Contractor shall ensure that:

a) worker safety is given priority in planning, pricing, and performing the Work;

b) its officers and supervisory employees have a working knowledge of the duties of a "Constructor" and "employer" as defined by the Act and the provisions of the Regulations applicable to the Work, and a personal commitment to comply with them;

c) a copy of the most current version of the Act and the Regulations are available at the Contractor's office within the Working Area, or, in the absence of an office, in the possession of the supervisor responsible for the performance of the Work;

d) workers employed to carry out the Work possess the knowledge, skills, and protective devices required by law or recommended for use by a recognized industry association to allow them to work in safety;

e) its supervisory employees are “Competent Persons” as defined in the OHSA, and carry out their duties in a diligent and responsible manner with due consideration for the health and safety of the workers;

f) all Subcontractors and their workers are properly protected from injury while they are at the Working Area; and

g) following execution of the Contract and prior to the issuance of the order to commence by the Owner, upon request the Contractor submits to the Contract Administrator a copy of the Notice of Project issued to the Ministry of Labour.

.02 The Contractor, when requested, shall provide the Owner with a copy of its health and safety policy and program at the pre-start meeting and shall respond promptly to requests from the Owner for confirmation that its methods and procedures for carrying out the Work comply with the Act and Regulations. The Contractor shall cooperate with representatives of the Owner and the inspectors appointed to enforce the Act and the Regulations in any investigations of worker health and safety in the performance of the Work. The Contractor shall indemnify and save the Owner harmless from any additional expense that the Owner may incur to have the Work performed as a result of the Contractor's failure to comply with the requirements of the Act and the Regulations.

.03 Prior to commencement of the Work, the Contractor shall provide to the Contract Administrator a list of those products controlled under the Workplace Hazardous Materials Information System ~~or~~ “WHMIS”, which the Contractor expects to use on the Contract. Related Safety Data Sheets shall accompany the submission. All containers used in the application of products controlled under “WHMIS” shall be labelled. The Contractor shall notify the Contractor Administrator in writing of changes in the products to be used and provide relevant Safety Data Sheets.

.04 During the course of the Work, the Contractor shall furnish forthwith to the Contract Administrator a copy of all correspondence, reports, orders or charges respecting occupational health and safety, including under the Act, Technical Standards and Safety Act, 2000, S.O. 2000, c.16 as amended, and the Criminal Code, R.S.C., 1985, c. C-46 as amended, which are received by, or which come to the notice of, the Contractor that apply or are relevant to any of the Work or activities conducted under the terms of the Contract.

.05 Nothing in this Contract shall be construed as requiring the Owner to monitor or approve the workplace health and safety practices of the Contractor.

GC 7.01.05 Contractor’s Representatives

.01 The Contractor shall have an authorized representative on the site while any Work is being performed, to supervise the Work and act for or on the Contractor's behalf. Prior to commencement of construction, the Contractor shall notify the Contract Administrator of the names, addresses, positions, and cell phone, and telephone numbers of the Contractor's representatives who can be contacted at any time to deal with matters relating to the Contract, and update as necessary.

.02 The Contractor shall designate a person to be responsible for traffic control and work zone safety. The designated person shall be a competent worker who is qualified because of knowledge, training, and experience to perform the duties; is familiar with Book 7 of the Ontario Traffic Manual; and has knowledge of all potential or actual danger to workers and motorists. Prior to the commencement of construction, the Contractor shall notify the Contract Administrator of the name; address; position; cell phone, and telephone numbers of the designated person, and update as necessary. The designated person may have other responsibilities, including other construction sites, and need not be present in the Working Area at all times.

GC 7.01.06 Assistance to the Contract Administrator

.01 The Contractor shall, at no additional cost to the Owner, furnish all reasonable aid, facilities, and assistance required by the Contract Administrator for the proper inspection and examination of the Work or the taking of measurements for the purpose of payment.

GC 7.01.07 Schedule

.01 The Contractor shall prepare and update, as required, a construction schedule of operations, indicating the proposed methods of construction and sequence of Work and the time the Contractor proposes to complete the various items of Work within the time specified in the Contract Documents. The schedule shall be submitted to the Contract Administrator within 14 Days from the Contract award. If the Contractor's schedule is materially affected by changes in the work, the Contractor shall submit an updated construction schedule, if requested by the Contract Administrator, within 7 Days of the request. This updated schedule shall show how the Contractor proposes to perform the balance of the Work, to complete the Work within the time specified in the Contract Documents.

.02 For Contracts with a specified number of Working Days, the construction time shown on the initial schedule shall not exceed the specified number of Working Days. The activities on the critical path shall assist the Contract Administrator in determining the Controlling Operation for the purpose of the charging of Working Days. The construction schedule shall include all non-working periods and appropriate allowances for Inclement Weather.

.03 For Contracts which specify a Contract Time, the construction time shown on the initial construction schedule shall not extend beyond the specified Contract Time. The construction schedule shall include all non-working periods and appropriate allowances for Inclement Weather.

GC 7.01.08 Errors and Inconsistencies Relating to the Contract

.01 Where the Contractor finds any error, inconsistency, or omission relating to the Contract, the Contractor shall promptly report it to the Contract Administrator and shall not proceed with the activity affected until receiving direction from the Contract Administrator.

.02 The Contractor shall promptly notify the Contract Administrator in writing if the subsurface conditions observed in the Working Area differ materially from those indicated in the Contract Documents.

GC 7.01.09 Utilities

.01 The Contractor shall arrange with the appropriate Utility authorities for the stake out of all underground Utilities and service connections that may be affected by the Work. The Contractor shall observe the location of the stake outs prior to commencing the Work and if there is a discrepancy between the location of the stake outs and the locations shown on the Contract Documents, that may affect the Work, the Contractor shall immediately notify the Contract Administrator and the affected Utility companies, in order to resolve the discrepancy. The Contractor shall be responsible for any damage done to the underground Utilities and service connections by

the Contractor's forces during construction if the stake out locations are within the tolerances given in clause GC 2.01.01 a).

.02 In the case of damage to or interference with any Utilities, pole lines, pipe lines, conduits, farm tiles, or other public or privately-owned works or property, the Contractor shall immediately notify the Owner, Contract Administrator, and the owner of the works of the location and details of such damage or interference.

GC 7.02 Monuments and Layout

.01 Prior to commencement of construction, the Contract Administrator and the Contractor shall locate on site those Monuments that delineate the Working Area and may be used to lay out the Work, all as shown on the Contract Drawings. Property Monuments shall be inventoried in the report format required by the Owner.

.02 These Monuments shall be protected by highly visible T-bars or 1.0 metre tall stakes with survey ribbon set within 0.3 metres of the Monument.

.03 The Contractor shall be responsible for the preservation of all Property Monuments while the Work is in progress, except those Property Monuments that must be removed to facilitate the Work as identified and agreed by the Contractor and Contract Administrator. Monuments removed to facilitate the Work shall be replaced at the Owner's expense, and all others shall be replaced at the Contractor's expense.

.04 All Monuments disturbed, damaged, or removed by the Contractor's operations shall be documented in the inventory report and replaced under the supervision of an Ontario Land Surveyor.

.05 The Monument inventory report referred to in clauses GC 7.02.01 and GC 7.02.04 shall include as a minimum:

a) Contract number, Contract name, Contract Administrator's name;
b) Project/site construction limits;
c) Rough location, type, identification number, and condition of each Monument before and after construction;
d) The solutions for protection of the Monuments that may be impacted by construction;
e) Reference ties;
f) A summary of those Monuments affected by the Work and how they were reset or replaced, and by what type of Monument.

.06 At no extra cost to the Owner, the Contractor shall provide the Contract Administrator with such materials and devices as may be necessary to lay out the baseline and benchmarks, and as may be necessary for the inspection of the Work.

.07 The Contractor shall provide qualified personnel to lay out and establish all lines and grades necessary for construction. The Contractor shall notify the Contract Administrator of any layout work carried out, so that the same may be checked by the Contract Administrator.

.08 The Contractor shall install and maintain substantial alignment markers and secondary benchmarks as may be required for the proper execution of the Work. The Contractor shall supply one copy of all alignment and grade sheets to the Contract Administrator.

.09 The Contractor shall assume full responsibility for alignment, elevations, and dimensions of each and all parts of the Work, regardless of whether the Contractor's layout work has been checked by the Contract Administrator.

.10 All stakes, marks, and reference points shall be carefully preserved by the Contractor. In the case of their destruction or removal, for any reason, before the end of the Contract Time such stakes, marks, and reference points shall be replaced, unless otherwise mutually agreed between the Contractor and the Contract Administrator, at the Contractor's expense.

.11 Benchmarks and survey monuments identified in the Contract Documents shall be protected by the Contractor. In the case of their destruction or removal, such benchmarks and survey monuments shall be replaced by the Owner at the Contractor's expense.

GC 7.03 Working Area

.01 The Contractor shall maintain the Working Area in a tidy condition and free from the accumulation of debris and prevent dust nuisance, mud, and ponding water, other than that caused by the Owner or others.

.02 The Contractor's sheds, site offices, toilets, other temporary structures, and storage areas for Material and Equipment shall be grouped in a compact manner, maintained in a neat and orderly condition at all times and removed upon completion of the Work.

.03 The Contractor shall confine the construction operations to the Working Area. Should the Contractor require additional space, the Contractor shall obtain such space at no additional cost to the Owner.

.04 The Contractor shall not enter upon or occupy any private property for any purpose, unless the Contractor has received prior written permission from the property owner.

.05 Upon completion of the Contract, the Working Area used by the Contractor shall be restored to its original condition or better unless otherwise specified in the Contract Documents including the removal of all excavated and stockpiled materials at the Contractor's expense.

GC 7.04 Damage by Vehicles or Other Equipment

.01 If at any time, in the opinion of the Contract Administrator, damage is being done or is likely to be done to any Roadway or any improvement thereon, outside the Working Area, by the Contractor's vehicles or other Equipment, whether licensed or unlicensed Equipment, the Contractor shall, on the direction of the Contract Administrator, and at no extra cost to the Owner, make changes or substitutions for such vehicles or Equipment, and shall alter loadings, or in some other manner, remove the cause of such damage to the satisfaction of the Contract Administrator.

GC 7.05 Excess Loading of Motor Vehicles

.01 Where a vehicle is hauling Material for use on the Work, in whole or in part; upon a Highway; and where motor vehicle registration is required for such vehicle, the Contractor shall not cause or permit such vehicle to be loaded beyond the legal limit specified in the Highway Traffic Act, R.S.O. 1990, c.H.8, as amended, whether such vehicle is registered in the name of the Contractor or otherwise, except where there are designated areas within the Working Area where overloading is permitted. The Contractor shall bear the onus of weighing disputed loads.

GC 7.06 Maintaining Roads and Detours

.01 Unless otherwise specified in the Contract Documents, if an existing Roadway is affected by construction, it shall be kept open to both vehicular and pedestrian traffic.

.02 Subject to the approval of the Contract Administrator, the Contractor shall, at no additional cost to the Owner, be responsible for providing and maintaining for the duration of the Work an alternative route for both pedestrian and vehicular traffic through the Working Area in accordance with the OTM,

whether along the existing Highway under construction or on a detour road beside or adjacent to the Highway under construction.

.03 Subject to the approval of the Contract Administrator, the Contractor may block traffic for short periods of time to facilitate construction of the Work in accordance with the OTM. Any temporary lane closures shall be kept to a minimum.

.04 The Contractor shall not be required to maintain a road through the Working Area until such time as the Contractor has commenced operations or during seasonal shut down or on any part of the Contract that has been accepted in accordance with these General Conditions. The Contractor shall not be required to apply de-icing chemicals or abrasives or carry out snowplowing.

.05 Where only localized and separated sections of the Highway are affected by the Contractor's operations, the Contractor shall not be required to maintain intervening sections of the Highway until such times as these sections are located within the limits of the Highway affected by the Contractor's general operations under the Contract.

.06 Where the Contract Documents provide for or the Contract Administrator requires detours at specific locations, payment for the construction of the detours and, if required, for the subsequent removal of the detours, shall be made at the Contract prices appropriate to such Work.

.07 Compensation for all labour, Equipment, and Materials to do this Work shall be at the Contract prices appropriate to the Work and, where there are no such prices, at negotiated prices. Notwithstanding the foregoing, the cost of blading required to maintain the surface of such roads and detours shall be deemed to be included in the prices bid for the various tender items and no additional payment shall be made.

.08 Where Work under the Contract is discontinued for any extended period, including seasonal shutdown, the Contractor shall, when directed by the Contract Administrator, open and place the Roadway and detours in a passable, safe, and satisfactory condition for public travel.

.09 Where the Contractor constructs a detour that is not specifically provided for in the Contract Documents or required by the Contract Administrator, the construction of the detour and, if required, the subsequent removal shall be performed at the Contractor's expense. The detour shall be constructed and maintained to structural and geometric standards approved by the Contract Administrator. Removal and site restoration shall be performed as directed by the Contract Administrator.

.10 Where, with the prior written approval of the Contract Administrator, the Highway is closed and the traffic diverted entirely off the Highway to any other Highway, the Contractor shall, at no extra cost to the Owner, supply, erect, and maintain traffic control devices in accordance with the OTM.

.11 Compliance with the foregoing provisions shall in no way relieve the Contractor of its obligations under subsection GC 6.01, Protection of Work, Persons, and Property, dealing with the Contractor's responsibility for damage claims, except for claims arising on sections of Highway within the Working Area that are being maintained by others.

GC 7.07 Access to Properties Adjoining the Work and Interruption of Utility Services

.01 The Contractor shall provide at all times and at no extra cost to the Owner,

a) safe and adequate pedestrian and vehicular access;

b) continuity of Utility services; and

c) access for emergency response services;

to properties adjoining the Working Area.

.02 The Contractor shall provide at all times and at no extra cost to the Owner access to fire hydrants, water and gas valves, and all other Utilities located in the Working Area.

.03 Where any interruptions in the supply of Utility services are required and are authorized by the Contract Administrator, the Contractor shall give the affected property owners notice in accordance with subsection GC 7.11, Notices by the Contractor, and shall arrange such interruptions so as to create a minimum of interference to those affected.

GC 7.08 Approvals and Permits

.01 Except as specified in subsection GC 4.02, Approval and Permits, the Contractor shall obtain and pay for any permits, licences, and certificates, which at the date of tender closing, are required for the performance of the Work.

.02 The Contractor shall arrange for all necessary inspections required by the approvals and permits specified in clause GC 7.08.01, Approvals and Permit.

GC 7.09 Suspension of Work

.01 The Contractor shall, upon written notice from the Contract Administrator, discontinue or delay any or all of the Work and Work shall not be resumed until the Contract Administrator so directs in writing. Delays, in these circumstances, shall be administered according to subsection GC 3.07, Delays.

GC 7.10 Contractor's Right to Stop the Work or Terminate the Contract

.01 If the Owner is adjudged bankrupt or makes a general assignment for the benefit of creditors because of insolvency or if a receiver is appointed because of insolvency, the Contractor may, without prejudice to any other right or remedy the Contractor may have, by giving the Owner or receiver or trustee in bankruptcy written notice, terminate the Contract.

.02 If the Work is stopped or otherwise delayed for a period of 30 Days or more under an order of a court or other public authority and provided that such order was not issued as the result of an act or fault of the Contractor or of anyone directly employed or engaged by the Contractor, the Contractor may, without prejudice to any other right or remedy the Contractor may have, by giving the Owner written notice, terminate the Contract.

.03 The Contractor may notify the Owner in writing, with a copy to the Contract Administrator, that the Owner is in default of contractual obligations if,

a) the Contract Administrator fails to issue certificates in accordance with the provisions of section GC 8.0, Measurement and Payment;

b) the Owner fails to pay the Contractor, within 28 Days of the due dates identified in clause GC 8.02.04, Certification and Payment, the amounts certified by the Contract Administrator or within 28 Days of an award by an arbitrator or court; or

c) the Owner fails to comply with the requirements of the Contract.

.04 The Contractor's written notice to the Owner shall advise that if the default is not corrected in the 7 Days immediately following receipt of the written notice, the Contractor may, without prejudice to any other right or remedy the Contractor may have, stop the Work or terminate the Contract.

.05 If the Contractor terminates the Contract under the conditions set out in subsection GC 7.10, Contractor's Right to Stop the Work or Terminate the Contract, the Contractor shall be entitled to be paid for all Work performed according to the Contract Documents and for any losses or damage as the Contractor may sustain as a result of the termination of the Contract.

GC 7.11 Notices by the Contractor

.01 Before any Work is carried out that may affect the property or operations of any Ministry or agency of government or any person; company; partnership; or corporation, including a municipal corporation or any board or commission thereof, and in addition to such notices of the commencement of specified operations as are prescribed elsewhere in the Contract Documents, the Contractor shall give at least 48 hours advance written notice of the date of commencement of such Work to the person, company, partnership, corporation, board, or commission so affected.

GC 7.12 Environmental Incident Management under Legislation Protecting the Environment and Natural Resources

.01 The Contractor shall be in strict compliance with the requirements of the following legislation, as amended, regarding environmental incidents under the control of the Contractor or that are a result of the Contractor's operations:

a) Environmental Protection Act, R.S.O. 1990, c. E.19

b) Fisheries Act, R.S.C. 1985, c. F-14

c) Technical Standards and Safety Act, 2000, S.O. 2000, c. 16

d) Pesticides Act, R.S.O. 1990, c. P.11

e) Ontario Water Resources Act, R.S.O. 1990, c. O.40

f) Transportation of Dangerous Goods Act, 1992, S.C.1992, c. 34

.02 The requirements of the legislation listed in clause GC 7.12.01 include but are not restricted to:

a) Immediate containment of the material, pollutant, contaminant, deleterious substance, or dangerous good;

b) Immediate notification of the environmental incident to the proper authority; and

c) Clean up and restoration of the environment to preconditions.

.03 The Contractor shall possess a plan demonstrating that environmental incidents shall be managed to satisfy the requirements of clauses GC 7.12.01 and GC 7.12.02.

.04 The Contractor shall provide a copy of the environmental incident plan to the Contract Administrator when required and shall inform the Contract Administrator immediately of:

a) An environmental incident when it occurs; and

b) Any actions taken or intended to be taken by the Contractor regarding the environmental incident.

.05 The Contractor shall indemnify and save the Owner harmless from any additional expense that the Owner may incur to have the Work performed as a result of the Contractor's failure to comply with the requirements of the legislation listed in clause GC 7.12.01.

GC 7.13 Obstructions

.01 Except as otherwise noted in these General Conditions, the Contractor assumes all the risks and responsibilities arising out of any obstruction encountered in the performance of the Work and any traffic conditions, including traffic conditions on any Highway or road giving access to the Working Area caused by such obstructions, and the Contractor shall not make any claim against the Owner for any loss, damage, or expense occasioned thereby.

.02 Where the obstruction is an underground Utility or other man-made object, the Contractor shall not be required to assume the risks and responsibilities arising out of such obstruction, unless the location of the obstruction is shown on the Plans or described in the Contract Documents and the location so shown is within the tolerance specified in clause GC 2.01.01 a), or unless the presence and location of the obstruction has otherwise been made known to the Contractor or could have been determined by the visual site investigation made by the Contractor in accordance with these General Conditions.

.03 During the course of the Contract, it is the Contractor's responsibility to consult with Utility companies or other appropriate authorities for further information in regard to the exact location of these Utilities, to exercise the necessary care in construction operations, and to take such other precautions as are necessary to safeguard the Utilities from damage.

GC 7.14 Limitations of Operations

.01 Except for such Work as may be required by the Contract Administrator to maintain the Work in a safe and satisfactory condition, the Contractor shall not carry out operations under the Contract on Saturdays, Sundays, and any holidays recognized by the Owner without permission in writing from the Contract Administrator.

.02 The Contractor shall cooperate and coordinate the Work with other Contractors, Utility companies, and the Owner and they shall be allowed access to their Work or plant at all reasonable times.

GC 7.15 Cleaning Up Before Acceptance

.01 Upon attaining Substantial Performance of the Work, the Contractor shall remove surplus materials, tools, and Equipment not required for the performance of the remaining Work. The Contractor shall also remove all temporary works and debris other than that caused by the Owner or others and leave the Work and Working Area clean and suitable for occupancy by the Owner, unless otherwise specified.

.02 The Work shall not be deemed to have reached Completion until the Contractor has removed surplus materials, tools, and Equipment. The Contractor shall also have removed debris, other than that caused by the Owner, or others.

GC 7.16 Warranty

.01 Unless otherwise specified in the Contract Documents for certain Materials or components of the Work, the Contractor shall be responsible for the proper performance of the Work only to the extent that the design and standards permit such performance.

.02 Subject to the previous paragraph the Contractor shall correct promptly, at no additional cost to the Owner, defects or deficiencies in the Work that appear,

a) prior to and during the period of 12 months from the date of Substantial Performance of the Work, as set out in the Certificate of Substantial Performance of the Work,

b) where there is no Certificate of Substantial Performance, 12 months from the date of Completion of the Work as set out in the Completion Certificate, or

c) such longer periods as may be specified in the Contract Documents for certain Materials or some of the Work.

The Contract Administrator shall promptly give the Contractor written notice of observed defects or deficiencies.

.03 The Contractor shall correct or pay for damage resulting from corrections made under the requirements of clause GC 7.16.02.

GC 7.17 Contractor's Workers

.01 The Contractor shall only employ orderly, competent, and skillful workers to do the Work and whenever the Contract Administrator shall inform the Contractor in writing that any worker or workers involved in the Work are, in the opinion of the Contract Administrator, incompetent, or disorderly such worker or workers shall be removed from the Work and shall not be employed on the Work again without the consent in writing of the Contract Administrator.

GC 7.18 Drainage

.01 During construction and until the Work is completed, the Contractor shall make all reasonable efforts to keep all portions of the Work properly and efficiently drained, to at least the same degree as that of the existing drainage conditions.

SECTION GC 8.0 - MEASUREMENT AND PAYMENT

GC 8.01 Measurement

GC 8.01.01 Quantities

.01 The Contract Administrator shall make an Estimate in writing once a month, unless otherwise specified in the Contract Documents, of the quantity of Work performed and provide such Estimate to the Contractor within 10 Days of the Cut-Off Date.

.02 Quantities for progress payments shall be construed and held to approximate. The final quantities for the issuance of the Completion Payment shall be based on the measurement of Work completed.

.03 Measurement of the quantities of the Work performed may be either by Actual Measurement or by Plan Quantity principles as indicated in the Contract. Adjustments to Plan Quantity measurements shall normally be made using Plan Quantity principles but may, where appropriate, be made using Actual Measurements. Those items identified on the Tender by the notation (P) in the unit column shall be paid according to the Plan Quantity. Items where the notation (P) does not occur shall be paid according to Actual Measurement or lump sum.

GC 8.01.02 Variations in Tender Quantities

.01 Where it appears that the quantity of Work to be done or Material to be supplied or both by the Contractor under a unit price tender item may exceed or be less than the tender quantity, the Contractor shall proceed to do the Work or supply the Material or both required to complete the tender item and payment shall be made for the actual amount of Work done or Material supplied or both at the unit prices stated in the Tender except as provided below:

a) In the case of a Major Item where the quantity of Work performed or Material supplied or both by the Contractor exceeds the tender quantity by more than 15%, either party to the Contract may make a written request to the other party to negotiate a revised unit price for that portion of the Work performed or Material supplied or both which exceeds 115% of the tender quantity. The negotiation shall be carried out as soon as reasonably possible. Any revision of the unit price shall be based on the actual cost of doing the Work or supplying the Material or both under the tender item plus a reasonable allowance for profit and applicable overhead. Alternatively, where both parties agree, an allowance equal to 10% of the unit price on the amount of the underrun in excess of 15% of the tender quantity shall be paid.

b) In the case of a Major Item where the quantity of Work performed or Material supplied or both by the Contractor is less than 85% of the tender quantity, the Contractor may make a written request to negotiate for the portion of the actual overheads and fixed costs applicable to the amount of the underrun in excess of 15% of the tender quantity. For purposes of the negotiation, the overheads and fixed costs applicable to the item are deemed to have been prorated uniformly over 100% of the tender quantity for the item. Overhead costs shall be confirmed by a statement certified by the Contractor's senior financial officer or auditor and may be audited by the Owner. Alternatively, where both parties agree, an allowance equal to 10% of the unit price on the amount of the underrun in excess of 15% of the tender quantity shall be paid.

Written requests for compensation must be received no later than 60 Days after the issuance of the Completion Payment.

GC 8.02 Payment

GC 8.02.01 Non-Resident Contractor

.01 If the Contractor is not a registered entity in Ontario, the Contractor shall obtain all necessary approvals, consents, permits, licences, certificates, registrations, and other authorizations prior to execution of the Contract.

.02 The Contractor shall ensure that all Subcontractors the Contractor proposes to use for carrying out any of the Work required by the Contract and who are not a registered entity in Ontario have obtained all necessary approvals, consents, permits, certificates, registrations, and other authorizations prior to execution of the subcontract.

GC 8.02.02 Price for Work

.01 Prices for the Work shall be full compensation for all labour, Equipment and Material required in its performance. The term "all labour, Equipment, and Material" shall include Hand Tools, supplies, and other incidentals.

.02 Payment, for Work which is identified in the Contract Documents but not specifically detailed as part of any one item shall be deemed to be included in the items with which it is associated.

GC 8.02.03 Advance Payments for Material

.01 The Owner shall make advance payments for Material intended for incorporation in the Work upon the written request of the Contractor and according to the following terms and conditions:

a) The Contractor shall deliver the Material to a site approved by the Contract Administrator and the Contractor shall, in advance of receipt of the shipment of the Material, arrange for adequate and proper storage facilities.

b) The value of aggregates, processed and stockpiled, shall be assessed by the following procedure:

i. Sources Other Than Commercial

(A) Granular A, B, BI, BII, BIII, M, and O shall be assessed at the rate of 60% of the Contract price.

(B) Coarse and fine aggregates for hot mix asphaltic concrete, surface treatment and Portland cement concrete shall be assessed at the rate of 25% of the Contract price for each aggregate stockpiled.

ii. Commercial Sources
Payment for separated coarse and fine aggregates shall be considered at the above rate when such Materials are stockpiled at a commercial source where further processing is to be carried out before incorporating such Materials into a final product. Advance payments for other Materials located at a commercial source shall not be made.

c) Payment for all other Materials, unless otherwise specified elsewhere in the Contract Documents, shall be based on the invoice price, and the Contractor shall submit proof of cost to the Contract Administrator before payment can be made by the Owner.

d) The payment for all Materials shall be prorated against the appropriate tender item by paying for sufficient units of the item to cover the value of the Material. Such payment shall not exceed 80% of the Contract price for the item.

e) All Materials for which the Contractor wishes to receive advance payment shall be placed in the designated storage location immediately upon receipt of the Material and shall thenceforth be held by the Contractor in trust for the Owner as collateral security for any monies advanced by the Owner and for the due completion of the Work. The Contractor shall not exercise any act of ownership inconsistent with such security, or remove any Material from the storage locations, except for inclusion in the Work, without the consent, in writing, of the Contract Administrator.

f) Such materials shall remain at the risk of the Contractor who shall be responsible for any loss, damage, theft, improper use, or destruction of the Material however caused.

.02 Where the Owner makes advance payments subject to the conditions listed in clause GC 8.02.03.01, such payment shall not constitute acceptance of the Material by the Owner. Acceptance shall only be determined when the Material meets the requirements of the appropriate specification.

GC 8.02.04 Certification and Payment

GC 8.02.04.01 Progress Payment

.01 The Contractor shall submit a Proper Invoice for progress payments monthly or at intervals specified in the Contract Documents after starting the Work on this Contract. The Contractor shall submit the Proper Invoice to the Contract Administrator and to the Owner. This Proper Invoice shall be for work completed at the agreed to Cut-Off Date.

.02 A Proper Invoice shall include;

a) the requirements as set out in section 6.1 of the Construction Act;

b) the quantities of Work performed;

c) the value of Work performed;

d) any advanced payment for Material;

e) the amount of Statutory Holdback, liens, Owner's set-off;

f) the amount of any applicable taxes;

g) the amount due to the Contractor; and

h) any other information that may be prescribed in the Contract Documents.

.03 Payment shall be made within 28 Days of the submission of the Proper Invoice unless a notice of non-payment has been issued in accordance with the Construction Act.

.04 The Owner shall retain the Statutory Holdback in the form and amount as required under the Construction Act.

GC 8.02.04.02 Certification of Subcontract Completion

.01 Before the Work has reached the stage of Substantial Performance, the Contractor may notify the Contract Administrator, in writing that a subcontract is completed satisfactorily and ask that the Contract Administrator certify the completion of such subcontract.

.02 The Contract Administrator shall issue a Certificate of Subcontract Completion, if the subcontract has been completed in a form satisfactory to the Contract Administrator, and all required inspection and testing of the works covered by the subcontract have been carried out and the results are satisfactory to the Contract Administrator.

.03 The Contract Administrator shall set out in the Certificate of Subcontract Completion the date on which the subcontract was completed and, within 7 Days of the date the subcontract is certified complete, the Contract Administrator shall give a copy of the certificate to the Contractor and to the Subcontractor concerned.

GC 8.02.04.03 Subcontract Statutory Holdback Release Certificate and Payment

.01 Following receipt of the Certificate of Subcontract Completion, the Owner shall release and pay the Contractor the Statutory Holdback retained in respect of the subcontract. Such release shall be made 61 Days after the date the subcontract was certified complete and providing the Contractor submits the following to the Contract Administrator:

a) a document satisfactory to the Contract Administrator that shall release the Owner from all further claims relating to the subcontract, qualified by stated exceptions such as holdback monies;

b) evidence satisfactory to the Contract Administrator that the Subcontractor has discharged all liabilities incurred in carrying out the subcontract;

c) a satisfactory clearance certificate or letter from the Workplace Safety and Insurance Board relating to the subcontract; and

d) a copy of the contract between the Contractor and the Subcontractor and a satisfactory statement showing the total amount due the Subcontractor from the Contractor.

.02 Clause GC 8.02.04.03.01 d), shall only apply to Lump Sum Items and then only when the Contract Administrator specifically requests it.

.03 Upon receipt of the Statutory Holdback, the Contractor shall forthwith give the Subcontractor the payment due under the subcontract.

.04 Release of Statutory Holdback by the Owner in respect of a subcontract shall not relieve the Contractor, or the Contractor's Surety, of any of their responsibilities.

GC 8.02.04.04 Substantial Performance of Work

.01 The Contractor, as part of the application for Substantial Performance, shall submit an itemized list of the outstanding work.

.02 Upon application by the Contractor and when the Contract Administrator has verified that the Contract has been substantially performed, the Contract Administrator shall issue a Certificate of Substantial Performance.

.03 The Contract Administrator shall set out in the Certificate of Substantial Performance the date on which the Contract was substantially performed and, within 7 Days after signing the said certificate, and shall provide a copy to the Contractor.

.04 Upon receipt of a copy of the Certificate of Substantial Performance, the Contractor shall forthwith, as required by Section 32(1) Paragraph 5 of the Construction Act, as amended, publish a copy of the certificate in the manner set out in the regulations.

.05 Where the Contractor fails to publish a copy of the Certificate of Substantial Performance as required above within 7 Days after receiving a copy of the certificate signed by the Contract Administrator, the Owner may publish a copy of the certificate at the Contractor's expense.

.06 Except as otherwise provided for in Section 31 of the Construction Act, the 60 Day lien period prior to the release of holdback as referred to in clause GC 8.02.04.05, Substantial Performance Payment and Statutory Holdback Release Payment Certificates, shall commence from the date of publication of the Certificate of Substantial Performance as provided for above.

GC 8.02.04.05 Substantial Performance Payment and Substantial Performance Statutory Holdback Release Payment Certificates

.01 Prior to the Contract Administrator issuing the Certificate of Substantial Performance, the Contractor shall submit a Proper Invoice for the Work completed. In addition to the requirements specified under section 8.02.04.01.02, the Proper Invoice shall include:

a) the value of Work performed to the date of Substantial Performance;

b) the value of outstanding or incomplete Work;

c) the amount of the Statutory Holdback, allowing for any previous releases of Statutory Holdback to the Contractor in respect of completed subcontracts and deliveries of pre-selected Equipment; and

d) the amount due the Contractor.

.02 Payment shall be made within 28 Days of the date of submission of the Proper Invoice.

.03 The Substantial Performance Statutory Holdback Release Payment Certificate shall be a payment certificate releasing to the Contractor the Statutory Holdback due in respect of Work performed up to the date of Substantial Performance. Payment of such Statutory Holdback shall be due 61 Days after the date of publication of the Certificate of Substantial Performance but subject to the provisions of the Construction Act and the submission by the Contractor of the following documents:

a) a satisfactory Certificate of Clearance from the Workplace Safety and Insurance Board; and

b) proof of publication of the Certificate of Substantial Performance.

.04 Any amount of security retained shall be identified on the Substantial Performance Payment Certificate.

GC 8.02.04.06 Certification of Completion

.01 Upon application by the Contractor and when the Contract Administrator has verified that the Contract has reached Completion, the Contract Administrator shall issue a Completion Certificate.

.02 The Contract Administrator shall set out in the Completion Certificate the date on which the Work was completed and, within 7 Days of signing the said certificate, the Contract Administrator shall provide a copy to the Contractor.

GC 8.02.04.07 Completion Payment and Completion Statutory Holdback Release Payment Certificates

.01 Prior to the Contract Administrator issuing the Completion Certificate, the Contractor shall submit a Proper Invoice for the Work completed. In addition to the requirements noted under section 8.02.04.01.02, the Proper Invoice shall include:

a) measurement and value of Work at Completion;

b) the amount of the further Statutory Holdback based on the value of further Work completed over and above the value of Work completed shown in the Substantial Performance Payment Certificate referred to above; and

c) the amount due the Contractor.

.02 The Completion Statutory Holdback Release Payment Certificate shall be a payment certificate releasing to the Contractor the further Statutory Holdback. Subject to any outstanding liens and permissible set-offs and upon submission of a satisfactory Certificate of Clearance from the Workplace Safety and Insurance Board, the Owner shall pay the remaining holdback on the Work done, within 28 Days after the expiration of the 60-Day lien period.

.03 Any amount of security retained shall be identified on the Completion Payment Certificate.

GC 8.02.04.08 Interest

.01 Interest due to the Contractor shall be based on simple interest and calculated using the applicable Rate of Interest. Interest shall begin to accrue on an amount that is not paid when it is due to be paid under Part-I of the Construction Act, at the prejudgment interest rate determined under subsection 127 (2) of the *Courts of Justice Act* or, if the Contract specifies a different interest rate for this purpose, the greater of the prejudgment interest rate and the interest rate specified in the Contract.

GC 8.02.04.09 Interest for Late Payment

.01 Provided the Contractor has complied with the requirements of the Contract, including all documentation requirements, when payment by the Owner to the Contractor for Work performed, or for release of Statutory Holdback, is delayed by the Owner, then the Contractor shall be entitled to receive interest on the outstanding payment at the Rate of Interest, if payment is not received on the dates set out below:

a) Progress Payment: 28 Days after submission of Proper Invoice;

b) Subcontract Statutory Holdback Release Payment: 89 Days after the date on which the subcontract was completed;

c) Substantial Performance Payment: 28 Days after the date of issuance of the certificate;

d) Substantial Performance Statutory Holdback Release Payment: 89 Days after publication of the Payment Certificate of Substantial Performance;

e) Completion Payment: 28 Days after the date certified as the date on which the Contract reached Completion; and

f) Completion Statutory Holdback Release Payment: 89 Days after the date certified as the date that the Work was completed.

.02 If the Contractor has not complied with the requirements of the Contract, including all documentation requirements, prior to expiration of the time periods described in clause GC 8.02.04.09.01, interest shall only begin to accrue when the Contractor has completed those requirements.

GC 8.02.04.10 Interest for Negotiations and Claims

.01 Except as hereinafter provided, where a notice of negotiation, notice of intent to claim and the subsequent claims are submitted in accordance with the time limits or procedure or both described by subsection GC 3.13, Claims, Negotiations, Mediation, the Owner shall pay the Contractor the Rate of Interest on the amount of the negotiated price for that part of the Work or on the amount of the settled claim. Such interest shall not commence until 30 Days after the satisfactory completion of that part of the Work.

.02 Where the Contractor fails to give notice of a claim within the time limit prescribed by subsection GC 3.13, Claims, Negotiations, Mediation, interest shall not be paid.

.03 Where a Contractor fails to comply with the 30 Day time limit and the procedures prescribed in clause GC 3.13.03.03 for submission of claims, interest shall not be paid for the delay period.

GC 8.02.04.11 Owner's Set-Off

.01 Pursuant to the Construction Act, the Owner may retain from monies owing to the Contractor under this Contract an amount sufficient to cover any outstanding or disputed liabilities, including the cost to remedy deficiencies, the reduction in value of substandard portions of the Work, claims for damages by third parties that have not been determined in writing by the Contractor's insurer, undetermined claims by the Owner, and any assessment due the Workplace Safety and Insurance Board.

.02 Under these circumstances the Owner will give the Contractor appropriate notice of such action.

GC 8.02.04.12 Delay in Payment

.01 The Owner shall not be deemed to be in default of the Contract provided any delay in payment does not exceed the due dates as defined in clause GC 8.02.04.09.01.

GC 8.02.05 Payment on a Time and Material Basis

GC 8.02.05.01 Definitions

.01 For the purpose of clause GC 8.02.05 the following definitions apply:

Cost of Labour means the amount of wages, salary, travel, travel time, food, lodging, or similar items and Payroll Burden paid or incurred directly by the Contractor to or in respect of labour and supervision actively and necessarily engaged on the Work based on the recorded time and hourly rates of pay for such labour and supervision but shall not include any payment or costs incurred for general supervision, administration, and management time spent on the entire Work or any wages, salary, or Payroll Burden for which the Contractor is compensated by any payment made by the Owner for Equipment.

Cost of Material means the cost of Material purchased or supplied from stock and valued at current market prices for the purpose of carrying out Extra Work by the Contractor or by others, when such arrangements have been made by the Contractor for completing the Work, as shown by itemized invoices.

Operated Rented Equipment means Rented Equipment for which an operator is provided by the supplier of the Equipment and for which the rent or lease includes the cost of the operator.

Payroll Burden means the payments in respect of workplace insurance, vacation pay, employment insurance, public liability and property damage insurance, sickness and accident insurance, pension fund, and such other welfare and benefit payments forming part of the Contractor's normal labour costs.

Rented Equipment means Equipment that is rented or leased for the special purpose of Work on a Time and Material Basis from a person, firm, or corporation that is not an associate of the lessee as the word "associate" is defined by the Securities Act, R.S.O. 1990, c.S.5, as amended, and is approved by the Contract Administrator.

Road Work means the preparation, construction, finishing, and construction maintenance of roads, streets, Highways, and parking lots and includes all work incidentals thereto other than Work on structures.

Sewer and Watermain Work means the preparation, construction, finishing, and construction maintenance of sewer systems and watermain systems, and includes all work incidental thereto other than Work on structures.

Standby Time means any period of time that is not considered Working Time and which together with the Working Time does not exceed 10 hours in any one Working Day and during which time a unit of Equipment cannot practically be used on other Work but must remain on the site in order to continue with its assigned task and during which time the unit is in fully operable condition.

Structure Work means the construction, reconstruction, repair, alteration, remodelling, renovation, or demolition of any bridge, building, tunnel, or retaining wall and includes the preparation for and the laying of the foundation of any bridge, building, tunnel, or retaining wall and the installation of Equipment and appurtenances incidental thereto.

The 127 Rate means the rate for a unit of Equipment as listed in OPSS.PROV 127, Schedule of Rental Rates for Construction Equipment, Including Model and Specification Reference, that is current at the time the work is carried out or for Equipment that is not so listed, the rate that has been calculated by the Owner, using the same principles as used in determining The 127 Rates.

Work on a Time and Material Basis means Changes in the Work, Extra Work, and Additional Work approved by the Contract Administrator for payment on a Time and Material basis. The Work on a Time and Material Basis shall be subject to all the terms, conditions, Standard Specifications and provisions of the Contract.

Working Time means each period of time during which a unit of Equipment is actively and of necessity engaged on a specific operation and the first 2 hours of each immediately following period during which the unit is not so engaged but during which the operation is otherwise proceeding and during which time the unit cannot practically be transferred to other Work but must remain on the site in order to continue with its assigned tasks and during which time the unit is in a fully operable condition.

GC 8.02.05.02 Daily Work Records

.01 Daily Work Records, prepared as the case may be by either the Contractor's representative or the Contract Administrator reporting the labour and Equipment employed and the Material used on each Time and Material project, should be reconciled and signed each Day by both the Contractor's representative and the Contract Administrator. If it is not possible to reconcile the Daily Work Records, then the Contractor shall submit the un-reconciled Daily Work Records with its claim, whereby the resolution of the dispute about the Daily Work Records shall not be resolved until there is a resolution of the claim.

GC 8.02.05.03 Payment for Work

.01 Payment as herein provided shall be full compensation for all labour, Equipment, and Material to do the Work on a Time and Material Basis except where there is agreement to the contrary prior to the commencement of the Work on a Time and Material Basis. The payment adjustments on a Time and Material basis shall apply to each individual Change Order authorized by the Contract Administrator.

GC 8.02.05.04 Payment for Labour

.01 The Owner shall pay the Contractor for labour employed on each Time and Material project at 135% of the Cost of Labour up to $3,500, then at 120% of any portion of the Cost of Labour in excess of $3,500.

.02 The Owner shall make payment in respect of Payroll Burden for Work on a Time and Material Basis at the Contractor's actual cost of Payroll Burden.

.03 At the Owner's discretion, an audit may be conducted in which case the actual Payroll Burden so determined shall be applied to all Time and Material work on the Contract.

GC 8.02.05.05 Payment for Material

.01 The Owner shall pay the Contractor for Material used on each Time and Material project at 120% of the Cost of the Material up to $3,500, then at 115% of any portion of the Cost of Material in excess of $3,500.

GC 8.02.05.06 Payment for Equipment

GC 8.02.05.06.01 Working Time

.01 The Owner shall pay the Contractor for the Working Time of all Equipment, other than Rented Equipment and Operated Rented Equipment, used on the Work on a Time and Material basis at The 127 Rates with a cost adjustment as follows:

a) Cost $12,000 or less - no adjustment;

b) Cost greater than $12,000 but not exceeding $24,000 - payment $12,000 plus 90% of the portion in excess of $12,000; and

c) Cost greater than $24,000 - $22,800 plus 80% of the portion in excess of $24,000.

.02 The Owner shall pay the Contractor for the Working Time of Rented Equipment used on the Work on a Time and Material Basis at 110% of the invoice price approved by the Contract Administrator up to a maximum of 110% of the 127 Rate. This constraint shall be waived when the Contract Administrator approves the invoice price prior to the use of the Rented Equipment.

.03 The Owner shall pay the Contractor for the Working Time of Operated Rented Equipment used on the Work on a Time and Material Basis at 110% of the Operated Rented Equipment invoice price approved by the Contract Administrator prior to the use of the Equipment on the Work on a Time and Material Basis.

GC 8.02.05.06.02 Standby Time

.01 The Owner shall pay the Contractor for Standby Time of Equipment at 35% of The 127 Rate or 35% of the invoice price whichever is appropriate. The Owner shall pay reasonable costs for Rented Equipment where this is necessarily retained in the Working Area for extended periods agreed to by

the Contract Administrator. This shall include Rented Equipment intended for use on other work, but has been idled due to the circumstances giving rise to the Work on a Time and Material Basis.

.02 In addition, the Owner shall include the Cost of Labour of operators or associated labourers who cannot be otherwise employed during the Standby Time or during the period of idleness caused by the circumstances giving rise to the Work on a Time and Material Basis.

.03 The Contract Administrator may require Rented Equipment idled by the circumstances giving rise to the Work on Time and Material Basis to be returned to the lessor until the Work requiring the Equipment can be resumed. The Owner shall pay such costs as a result from such return.

.04 When Equipment is transported, solely for the purpose of the Work on a Time and Material Basis, to or from the Working Area on a Time and Material basis, payment shall be made by the Owner only in respect of the transporting units. When Equipment is moved under its own power it shall be deemed to be working. The method of moving Equipment and the rates shall be subject to the approval of the Contract Administrator.

GC 8.02.05.07 Payment for Hand Tools

.01 Notwithstanding any other provision of this Section, no payment shall be made to the Contractor for or in respect of Hand Tools or Equipment that are tools of the trade.

GC 8.02.05.08 Payment for Work by Subcontractors

.01 Where the Contractor arranges for Work on a Time and Material Basis, or a part of it, to be performed by Subcontractors on a Time and Material basis and has received approval prior to the commencement of such Work, in accordance with the requirements of subsection GC 3.09, Subcontracting by the Contractor, the Owner shall pay the cost of Work on a Time and Material Basis by the Subcontractor calculated as if the Contractor had done the Work on a Time and Material Basis, plus a markup calculated on the following basis:

a) 20% of the first $3,500; plus

b) 15% of the amount from $3,500 to $12,000; plus

c) 5% of the amount in excess of $12,000.

.02 No further markup shall be applied regardless of the extent to which the work is assigned or sublet to others. If Work is assigned or sublet to an associate, as defined by the Securities Act, no markup whatsoever shall be applied.

GC 8.02.05.09 Submission of Invoices

.01 At the start of the Work on a Time and Material Basis, the Contractor shall provide the applicable labour and Equipment rates not already submitted to the Contract Administrator during the course of such Work.

.02 Separate summaries shall be completed by the Contractor. Each summary shall include the Change Directive or Change Order number and covering dates of the Work and shall itemize separately the labour, Materials, and Equipment. Invoices for Materials, Rented Equipment, and other charges incurred by the Contractor on the Work on a Time and Material Basis shall be included with each summary.

.03 Each month the Contract Administrator shall include with the monthly progress payment, the costs of the Work on a Time and Material Basis incurred during the preceding month all in accordance with the contract administrative procedures and the Contractor's invoice of the Work on a Time and Material Basis.

.04 The final summary as per clause 8.02.05.09.02 shall be submitted by the Contractor within 60 Days after the completion of the Work on a Time and Material Basis.

GC 8.02.05.10 Payment Other Than on a Time and Material Basis

.01 Clause GC 8.02.05 does not preclude the option of the Contract Administrator and the Contractor negotiating a Lump Sum Item or unit price payment for Change in the Work, Extra Work, and Additional Work.

GC 8.02.05.11 Payment Inclusions

.01 Except where there is agreement in writing to the contrary, the compensation, as herein provided, shall be accepted by the Contractor as compensation in full for profit and all costs and expenses arising out of the Work, including all cost of general supervision, administration, and management time spent on the Work, and no other payment or allowance shall be made in respect of such Work.

GC 8.02.06 Final Acceptance Certificate

.01 After the acceptance of the Work or, where applicable, after the Warranty Period has expired, the Contract Administrator shall issue the Final Acceptance Certificate. The Final Acceptance Certificate shall not be issued until all known deficiencies have been adjusted or corrected, as the case may be, and the Contractor has discharged all obligations under the Contract.

.02 Any remaining amount of security shall be released upon Final Acceptance of the Contract.

GC 8.02.07 Records

.01 The Contractor shall maintain and keep accurate Records relating to the Work, Changes in the Work, Extra Work, Additional Work and claims arising therefrom. Such Records shall be of sufficient detail to support the total cost of the Work, Changes in the Work, Extra Work, Additional Work and claims arising therefrom. The Contractor shall preserve all such original Records until 12 months after the Final Acceptance Certificate is issued or until all claims have been settled, whichever is longer. The Contractor shall require that Subcontractors employed by the Contractor preserve all original Records pertaining to the Work, Changes in the Work, Extra Work, Additional Work and claims arising therefrom for a similar period of time.

.02 The Owner may inspect and audit the Contractor's Records relating to the Work, Changes in the Work, Extra Work, and Additional Work at any time during the period of the Contract. The Contractor shall supply certified copies of any part of its Records required, whenever requested by the Owner.

GC 8.02.08 Taxes

.01 Where a change in Canadian Federal or Provincial taxes occurs after the date of tender closing for this Contract, and this change could not have been anticipated at the time of Tender, the Owner shall increase or decrease Contract payments to account for the exact amount of tax change involved.

.02 Claims for compensation for additional tax cost shall be submitted by the Contractor to the Contract Administrator on forms provided by the Contract Administrator to the Contractor. Such claims for additional tax costs shall be submitted not less than 30 Days after the date of Final Acceptance.

.03 Where the Contractor benefits from a change in Canadian Federal or Provincial taxes, the Contractor shall submit to the Contract Administrator on forms provided by the Contract Administrator, a statement of such benefits. This statement shall be submitted not later than 30 Days after Final Acceptance.

.04 Changes in Canadian Federal or Provincial taxes that impact upon commodities, which when left in place form part of the finished Work, or the provision of services, where such services form part of the Work and where the manufacture or supply of such commodities or the provision of such services is carried out by the Contractor or a Subcontractor, are subject to a claim or benefit as detailed above. Services in the latter context means the supply and operation of Equipment, the provision of labour, and the supply of commodities that do not form part of the Work.

.05 The Contractor shall add the Harmonized Sales Tax (HST) to all invoices.

GC 8.02.09 Liquidated Damages

.01 When liquidated damages are specified in the Contract and the Contractor fails to complete the Work in accordance with the Contract, the Contractor shall pay such amounts as are specified in the Contract Documents.

GENERAL SPECIFICATION FOR WEIGHING OF MATERIALS

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APPENDICES

102.01 SCOPE

This specification covers the requirements for the weighing of materials where payment is based on mass.

102.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be as specified in the Contract Documents.

102.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

102.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Government of Canada Weights and Measures

Government of Canada Weights and Measures Act (R.S.C., 1985, O. W-6), revised August 1, 2014.

Government of Canada Weights and Measures Regulations, 2014-08-01

102.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Limits of Error: means the in service limits of error contained in the Government of Canada Weights & Measures Act.

Weigh Scales, weigh machines: means any device that measures mass and has a moving or movable part that has or can have an effect on the accuracy of the device.

102.04 DESIGN AND SUBMISSION REQUIREMENTS

102.04.01 Testing and Certification of Scales

102.04.01.01 Testing Procedures

The Contract Administrator shall be notified a minimum of 48 hours in advance of any test to be carried out on the weigh scales. The Contract Administrator shall be present throughout the duration of the test. Failure to comply may result in a re-test being required.

102.04.01.02 Portable Scales

Portable scales shall be tested and certified conforming to the Government of Canada Weights and Measures Act and Government of Canada Weights and Measures Regulations.

A completed copy of the Heavy-Duty Scale Inspection Report form CCA-1409IC3161E of the Measurement Canada, the Federal Government of Canada shall be sent to the nearest office of the District Inspector of the Weights and Measures Division in each of the following circumstances:

a) After the initial installation on a contract and before use on that contract.

b) When the scale is moved to a new location.

c) When the scale has undergone adjustments, alterations, or repairs to the weighing mechanism.

d) When weighing is resumed after winter suspension.

e) When digital heads are changed or added.

A duplicate copy of the above report shall be on view in the scale house or trailer before weighing operations commence and at all times thereafter.

102.04.01.03 Permanently Installed Scales

Permanently installed scales shall show a Government of Canada Certificate of Inspection or Device Examination Certificate (IC3562E).

When a rejection tag is on display and the Government of Canada certificate of inspection is shown as not currently in effect, but subsequent alterations, adjustments, or repairs have been carried out, verification of this work is required by the Contract Administrator and should either be on display or located on file in the scale house or trailer. Verification shall be documented on form IC3161E including the following minimum requirements:

a) Date work carried out.

b) Items required, altered, or adjusted.

c) Name and signature of person performing the work and name of firm or organization responsible for the work.

102.04.01.04 Conveyor Scales

Conveyor scales shall be certified by an Inspector of the Government of Canada, Weights and Measures.

a) After the initial installation on a contract and before use on that contract.

b) After every relocation on that contract.

102.06 EQUIPMENT

102.06.01 General

When the contract includes items that require measurement for payment by weighing, weigh scales shall be provided that meet the requirements of the Government of Canada Weights and Measures Act and Regulations for the purposes for which they shall be used.

102.06.02 Platform Scales

Platform scales shall be of sufficient capacity and dimension to fully contain the loaded vehicle or coupled vehicle combination in one setting and to permit weighing of the entire load in one operation. Weighing of various axle combinations in more than one operation shall not be permitted. Scale foundations shall be adequate to support the largest gross load without any settlement occurring during the weighing operation. Scale pits shall be properly drained. Substantial retaining walls that may be concrete, shall be built at each end of the scale platform to support the entrance and exit ramps. These retaining walls shall be of sufficient strength and placed to support the ramp material without binding on the ends of the platform.

The platform scale equipment for bar coding shall be identified as per the Contract Documents.

In order to minimize the effect of impact loads on the scale adjustment and to reduce the effect of vehicle braking and kickback on the scale platform and scale adjustments, the approach ramp shall be constructed conforming to the weights and measures requirements on a straight and level grade at the same elevation as the scale platform. Vehicles shall enter and leave the platform at a maximum speed of 8.0 km/h.

The scale platform and mechanism shall at all times be maintained, clean, and free from encumbrances such as gravel, asphalt, snow, and ice. The mass indicator mechanism shall be enclosed in the scale house or trailer.

102.06.03 Conveyor Scales

In order to ensure that the required operating temperature has been reached, electric power for conveyor scales shall be applied to the weighing system at least 30 minutes before the commencement of weighing.

Each conveyor scale shall be provided with a calibration chain certified by the testing agency of the Government of Canada and readily available at all times.

The mass recording device shall clearly indicate the mass, so that weigh tickets can be conveniently completed by the weigher.

The mass recording device shall be enclosed in the scale house or trailer.

Span calibration controls shall be sealed during the period of operation and accessible only to the testing personnel.

102.06.04 Scale Houses or Trailers

Each scale house or trailer shall be properly ventilated and shall be clean, dry, and weathertight, with a minimum floor space of 4.5 m^2 and minimum head room of 2.1 m. They shall be equipped with windows that can be opened and closed from within and from which the weigher, while seated at the scale or console, has an unobstructed view of the vehicle to be weighed, the scale platform or conveyor, and the approach ramp.

Each scale house or trailer shall also have the following:

a) A free sliding window or other approved means for passing out weigh tickets.

b) Screens for doors and windows.

c) A door located remotely from the scale platform suitable for the occupant's unobstructed exit in case of fire.

d) Theft and vandal-proof locking devices for doors and windows.

e) Door key for the weigher.

f) Table, chair, and bench, so that the weigher can be seated during weighing operations in front of the scale or console.

g) Heating equipment sufficient to maintain the temperature in the scale house at 20°C.

h) Adequate lighting to facilitate office work.

i) Fuel for heating and lighting.

j) Sanitary facilities within 100 m of the scale house or trailer.

102.07 CONSTRUCTION

102.07.01 Weighing

102.07.01.01 Mass Measurements

Mass measurements shall be made by a weigher supplied by the Contract Administrator, except when the weigh scales to be used are equipped with an automatic printing device (such as bar codes) capable of producing tickets as per the Contract Documents.

102.07.01.02 Scale Location

Scales for weighing hot mixed asphaltic concrete shall be located at the mixing plant. Scales for weighing other materials shall be installed at locations selected by the Contractor.

When material is from a commercial source, the tickets issued at the source are acceptable providing the weighing operation conforms to this specification.

When in the opinion of the Contract Administrator, waste or loss of material between the above scale location and the material's intended destination on the contract occurs, the hauling operation may be terminated until a scale has been provided on a site that is approved by the Contract Administrator and that is close enough to the intended destination to preclude the possibility of waste or loss.

102.07.01.03 Vehicle Tares

102.07.01.03.01 General

Vehicles shall be tared for all weighing operations with the normal hauling complement of driver, accessories, and fuel.

The same scale shall be used for truck taring and establishing gross vehicle mass and the mass of the material to be delivered, with the exception of commercial sources, where separate tare scales are permitted in the same pit or quarry providing the electronics are interfaced from one scale to the other.

Each truck and each coupled vehicle combination shall have a distinguishing number prominently displayed where it will be readily visible to the weigher.

102.07.01.03.02 Weighing Non-Liquid Materials

When a platform scale is being used on the contract, the tares of the hauling vehicles shall be determined randomly at least once daily, and more frequently if required by the Owner.

102.07.01.03.03 Weighing Liquid Materials

Weighing of liquid materials shall be carried out on permanently installed scales with automatic printing devices.

102.07.01.03.04 Volumetric Measurement

When specified in the Contract Documents as an alternative to weighing, a metering device, conforming to the Government of Canada Weights and Measures Act and Regulations thereto, shall be used in the conversion of liquid volume to an equivalent mass in tonnes, using the factor specified in the Contract Documents.

102.07.01.04 Use of Weigh Scales by Enforcement Officers

During normal Contract working hours, weigh scales shall be at the disposal of Provincial Police Officers and enforcement officers of the Owner for the purpose of checking the mass of the loads of vehicles employed on this Contract.

Scale houses or trailers shall be accessible during normal Contract working hours so that weighing records may be examined.

102.08 QUALITY ASSURANCE

102.08.01 Scale Accuracy

The Owner reserves the right to check the accuracy or test the Contractor's scales at any time.

When a device is found to be in error, less than three times the limits of error, the Owner shall accept material measured for payment by the device for a period of 48 hours from the time the Contractor is notified in writing that the error exceeds the limits of error.

When a device is found to be in error, in excess of three times the limits of error, the Owner shall immediately cease to accept material measured for payment by the device.

102.08.01.01 Conveyor Scales

A conveyor scale test shall be conducted a minimum of twice weekly or as required by the Owner. A minimum ten minute run is required for this test.

The material shall be collected in truck boxes and the total mass for each truck recorded. The material shall be reweighed on a recently verified platform scale and the material mass compared. The maximum allowable variation between the truck scale mass and the conveyor scale mass shall not exceed 0.5%. The test results shall be recorded and available at all times.

The Contractor shall be responsible for arranging the use of the platform scale.

102.10 BASIS OF PAYMENT

102.10.01 Weighing

Payment at the Contract price for the tender items that require the weighing of material shall be full compensation for all labour, Equipment, and Material to carry out the weighing operation including any delay or inconvenience due to any checking or testing carried out by the Owner.

Appendix 102-A, November 2018
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- The platform scale may be equipped with a direct cable connection to the computer for the purpose of sending mass measurements. A printing device connected by direct cable connection to the computer may be capable of electronically producing tickets. (102.06.01)
- The Contractor may provide personnel to conduct the mass measurements. The mass measurements may be sent to the printing device using a print command on the computer. Any form of override of the printing process, except total transaction rejection, will not be allowed.

Tickets may be supplied by the Contractor. Bar codes may be printed directly onto the weigh ticket or onto labels. Bar coded labels shall be affixed to the Owner's copy of the ticket before it leaves the weigh scale building.

The following information may be displayed as bar code groups printed in a column or left to right configuration:

1) Truck Number
2) Tare Weight
3) Net Weight
4) Ticket Number

The words "Truck", "Tare", "Net", and "Ticket" must appear beneath each appropriate bar code group.

Conventional alphanumerics may be used elsewhere on the ticket to express the exact information contained in the bar codes.

Automated reading failure rates greater than one reading failure in twenty tickets scanned and attributable to the density or configuration of the bar codes are not acceptable. Where such rates of reading failure occur, the Contractor must take corrective action to enhance the bar code symbology to an acceptable level immediately following notification of the problem.

The bar code symbols may conform to the American National Standard for Materials Handling - Linear Bar Code and Two-Dimensional Symbols Used in Shipping, Receiving, and Transport Applications (ANSI MH10.8.1-2005) for 3 of 9 bar code (Code 39).

The minimum bar code height may be 6.4 mm or 15 percent of the bar code length, whichever is greater.

In addition to the bar code group information, each weigh ticket may contain the following:

a) licence plate number of unit(s)
b) time and date of transaction
c) truck owner
d) contract number
e) type of material
f) source of material

g) gross weight
h) overload notation
i) running total of each material
j) a place for the checker to sign

For each contract, the following reports may be produced daily:

- truck register, including allowable gross weight for all vehicles;
- truck tare report for all vehicles, including old and new tares, and time recorded;
- summaries for each type of material;
- summaries for all cancelled loads.

The above reports may be available for the Contract Administrator to pick-up at the end of daily operations or before start-up the following day.

A sample weigh ticket from each source must be supplied to the Owner two weeks prior to delivery of the material.
- Identify if a metering device and its factor, conforming to the Government of Canada Weights and Measures Act and Regulations thereto, is to be used in the conversion of liquid volume, to an equivalent mass in tonnes. (102.07.01.03.04)
The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

GENERAL SPECIFICATION FOR ELECTRICAL WORK

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106-A **Commentary**

106.01 SCOPE

This specification covers the general requirements for electrical work and is applicable to all electrical work in the Contract.

106.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

106.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

106.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 609	Grounding
OPSS 611	Installation of Underpass Luminaires
OPSS 614	Installation of Power Supply Equipment
OPSS 617	Installation of Roadway Luminaires
OPSS 620	Traffic Signal Equipment and Electrical Traffic Control Devices
OPSS 630	Installation of Sectional Steel High Mast Lighting Poles

Ontario Ministry of Transportation Publications

Ontario Traffic Manual (OTM):
Book 7 - Temporary Conditions

Electrical Safety Authority (ESA)

Ontario Electrical Safety Code

106.03 DEFINITIONS

For the purpose of this specification, definitions in the Ontario Electrical Safety Code and the following definitions apply:

Cable means a solid or stranded, bare or insulated metal conductor (wire) or group of conductors enclosed in a common jacket or twisted to form a group.

Certificate of Conformance means a document issued by the Quality Verification Engineer confirming that the specified components of the Work are in general conformance with the requirements of the Contract Documents.

Down Time means the time during which an electrical system is de-energized or not under full operation.

Duct means a circular pipe or conduit for the mechanical protection of cables.

Electrical Chamber means a chamber for placing and maintaining conductors, cables, ducts, or electrical equipment. A general name for electrical maintenance holes and handholes.

Electrical Maintenance Hole means a subsurface chamber large enough for a person to enter that allows facilities for placing and maintaining underground conductors, cables, and associated apparatus.

Electrical Work means any work associated with the installation, modification, removal, inspection, or testing of electrical system components, including work required for all auxiliary concrete, mechanical, metallic, or non-electrical components required for the work.

Electrician means a person in possession of a certificate of qualification for the trade of Electrician, Construction and Maintenance, 309A or 309D, issued by the Ministry of Training, Colleges and Universities, Ontario.

Emergency Maintenance or Emergency Repairs means an activity required to repair unexpected failure of electrical equipment components that requires immediate action and takes precedence over routine maintenance activities for the duration of the emergency.

Energized means electrically live.

Engineer means a professional engineer licensed by the Professional Engineers of Ontario to practice in the Province of Ontario.

ESA means Electrical Safety Authority.

High Mast Lighting Equipment means high mast poles complete with luminaire raising and lowering devices consisting of ring assemblies complete with tenon arms, shrouds, external or internal drive mechanisms, and pole anchorage assemblies.

Highway Lighting System means a system of luminaires, poles, sign luminaires, underpass illumination, cables, power supply equipment, control system, and all associated materials required to provide illumination on a highway, roadway, or associated appurtenances.

IMSA means International Municipal Signal Association.

Luminaire means a complete lighting unit consisting of a lamp or lamps together with the parts designed to distribute the light, to position and protect the lamps, and to connect the lamps to the power supply.

Nighttime means the time during which the ambient natural horizontal illuminance at ground level is less than 15 lux.

Non-Routine Maintenance means any activity, other than routine maintenance activities, required to bring the electrical systems to full functionality according to standards.

Pad means a concrete footing with a level surface used to mount electrical equipment or for a temporary installation that could be made of wood.

Power Supply Equipment means electrical equipment installed to provide a source of power for electrical systems and includes transformation, switching, and control equipment.

Quality Verification Engineer (QVE) means a representative of the Owner qualified to provide the services specified in the Contract Documents.

Record Drawings means drawings illustrating constructed deviations from the original Contract Drawings in hard copy and scanned digital copy. Authorized deviations from the original Contract Drawings are marked up in red on one set of Contract Drawing prints in a neat legible manner.

Routine Maintenance means ongoing preventive maintenance activities according to the manufacturer's recommendations and the Owner's maintenance standards and includes the periodic adjustment of the electrical system components to correct deviations from the system specifications resulting from normal operation of the system.

Service Manuals means the full literature, drawings, directives, instructions, and procedures issued by the supplier or manufacturer of any system component for the purposes of assembly, installation, operation, preventive maintenance, or emergency maintenance of the system component.

Signalized Intersection means an intersection or junction of roadways or crosswalks or both where the vehicular and pedestrian traffic is controlled by a traffic signal system.

Switchover means the act of closing down an electrical system and bringing a new or modified electrical system into operation.

System Components means all hardware and software components, devices, parts, and materials included in the electrical work supplied and installed under a Contract, including all spare parts supplied by the Contractor.

Temporary means work that is done to serve a specific function and removed on the same Contract as it was placed.

Traffic Signal System means a system of traffic signal equipment, poles, traffic signal controllers, traffic signal actuation and interconnection equipment, and all associated materials required to regulate vehicular and pedestrian traffic.

Underpass Illumination means any work required for the installation of luminaires on the ceilings, walls, beams, abutments, or piers of a bridge or retaining walls.

106.04 DESIGN AND SUBMISSION REQUIREMENTS

106.04.01 Submission Requirements

106.04.01.01 Electrical Equipment Working Drawings

Working Drawings for the following electrical equipment are required:

a) Luminaires.

b) High-voltage switches and fuses.

c) Transformers.

d) Distribution assemblies.

e) Supply control cabinet assemblies.

f) Traffic signal control cabinet assemblies.

g) Anchorage assemblies.

h) High mast lighting equipment (i.e., poles, and raising and lowering equipment).

i) High mast luminaires.

j) Advanced traffic management systems (ATMS) equipment.

k) Traffic data collection systems equipment.

l) Roadway weather information systems equipment.

Working Drawings for luminaires shall consist of manufacturer's catalogue information and photometric data. Working Drawings for all other items shall include all information required in the Contract Documents.

Working Drawings for all items shall include all information required in the applicable Owner’s material specification.

Materials and dimensions shown on the final Working Drawings shall not be changed without approval of the Contract Administrator. Resubmission of Working Drawings showing any changes to the final Working Drawings is required.

106.04.01.02 Submission of Drawings

Seven sets of electrical equipment Working Drawings shall be submitted to the Contractor Administrator prior to the commencement of fabrication.

106.04.01.03 Return of Submissions

Each submission or resubmission shall be reviewed and returned within 4 weeks.

Three copies of the electrical equipment Working Drawings to be returned, shall be marked as one of the following:

a) Stamped with wording that allows for permission to construct.

In this case, the Contractor shall then submit another seven copies of these final drawings to the Contract Administrator, who shall stamp them with wording that allows for permission to construct. Work can commence on receipt of the drawings by the Contractor.

b) Showing only required changes.

In this case, the drawings shall be updated as required and the submission process repeated.

Once fabrication of the electrical equipment has commenced, materials and dimensions shown on the final Working Drawings shall not be changed.

106.05 MATERIALS

All similar electrical materials, equipment, components, or completed assemblies of components shall be approved according to the Ontario Electrical Safety Code.

106.07 CONSTRUCTION

106.07.01 Qualification of Workers

106.07.01.01 Contractor's Representative

A representative, who is experienced in the electrical work to be performed, shall be appointed to represent the Contractor.

The Contractor's representative shall attend such meetings required by the Owner to coordinate services affected by the Contract.

106.07.01.02 Contractor’s Workers

The Contractor or electrical subcontractor shall be a licensed electrical contractor according to the Electricity Act and shall use workers qualified to do the electrical work according to the following:

a) All electrical and advanced traffic management system work shall be performed by or under the direct personal supervision of an electrician.

b) Traffic signal and traffic signal control equipment installation, inspection, and testing shall be performed by an electrician who has successfully completed one of the following:

   i. Levels 1 and 2 of the IMSA Traffic Signal Technician Certification Program
   ii. Ministry of Transportation’s (MTO) 170 Training Course and 170 Advanced Training Course
   iii. 170-332 IMSA/MTO Certification Program

c) All high mast lighting installation, inspection, and testing shall be performed by an electrician who has successfully completed training from the manufacturers.

d) All locates for electrical systems and advanced traffic management systems shall be performed by a licenced electrician who has successfully completed cable locate training.

e) All electrical testing and inspection work shall be performed by an electrician.

The Contract Administrator may request at any time that the Contractor provide proof that the individual performing or supervising the electrical work is an electrician. If such a person is not present, the Contract Administrator may direct the Contractor to cease all electrical work until an electrician, with proof of such, is on site to perform or supervise the electrical work.

106.07.01.03 High-Voltage Work

High-voltage work shall be performed by qualified personnel.

106.07.02 Work to be Inspected by Electrical Safety Authority

All electrical work is subject to inspection by the ESA. The Contractor shall perform all work associated with inspection or re-inspection by the ESA. This work includes, but is not limited to the following:

a) Arranging and coordinating all visits to the construction site by the ESA's inspectors.

b) Correcting all defects identified by the ESA.

c) Submitting all applications for inspection.

d) Obtaining all permits.

e) Obtaining all certificates.

f) Obtaining all connection authorizations from the ESA.

g) Payment of fees.

h) Performing any other work that may be required under the Ontario Electrical Safety Code.

106.07.03 Work to be Coordinated with Others

The Contractor shall coordinate for the following work:

a) Electrical power supply connection and disconnection by the electrical power supply authority.

b) Communication connection and disconnection by the communication providers.

c) Mounting of any electrical equipment on a pole or any structure owned by or under the jurisdiction of a Utility authority.

d) Mounting of any electrical equipment in close proximity to or requiring modification of any plant owned by a Utility authority, private person, or other company.

The Contractor shall notify the Contract Administrator in writing at least 15 Business Days prior to commencing the above work. A detailed breakdown of the required Utility work and the corresponding Utility cost to complete the work, along with a Utility authority contact name, address, and telephone number, shall be provided to the Contract Administrator.

Utility authority invoices for the above work shall be forwarded to the Contract Administrator.

Obtaining all connection authorizations and layouts shall be completed by the Contractor.

The Contractor shall provide 2 copies of all Utility service layouts to the Contract Administrator.

The Contract Administrator and the Owner's electrical coordinator shall be notified a minimum of 72 hours in advance of all service layout meetings with an electrical power supply authority. The Contractor shall obtain electrical power supply billing account details from the Contract Administrator and provide them to the electrical power supply authority.

The Contractor shall locate all of the electrical systems and advanced traffic management systems within the limits of the Contract. The Contractor shall complete all locates on the Owner's electrical systems and advanced traffic management systems required for the Contractor to do the Work. The Contractor shall not rely on the Owner to complete the locates.

106.07.04 Traffic Signal Systems

106.07.04.01 General

Testing of signal displays and switch on for operation of traffic signals shall be under police supervision. Switch on and switchover for operation is not permitted on Mondays, Fridays, Saturdays, Sundays, and statutory holidays.

106.07.04.02 Existing Traffic Signal Systems

Except when the Contract requires modifications to existing traffic signal systems, the Contractor shall perform the operations with the existing traffic signal systems undisturbed and fully operational. When traffic signal systems are to be installed and the existing traffic signal system is to be removed or modified, the new traffic signal system shall be installed independently of the existing system such that short duration switchover from one system to the other is effected without appreciable down time.

106.07.04.03 New Traffic Signal Systems Activation

A new traffic signal system at a location not previously signalized shall be initially switched on for operation according to the following requirements:

a) For the testing of circuitry and components, operation of the system shall take place with signal head covers in place.

b) The Contract Administrator shall be given a minimum of 5 Days notice of when the system shall be ready for operation and 24 hours notice prior to completion of the work. Confirmation is to be given that the work shall be done as scheduled.

c) The Contractor shall complete all preliminary system testing as specified in the Contract Documents and all repairs or replacement of defective components prior to final energizing.

106.07.04.04 Traffic Signal Systems Switchover

A new traffic signal system installed to replace an existing traffic signal system shall be initially switched on for operation according to the following requirements:

a) The Contract Administrator shall be given a minimum of 3 Days notice of when the system switchover shall be done and 24 hours notice prior to completion of the work. Confirmation is to be given that the work shall be done as scheduled.

b) All preliminary system testing shall be completed as specified in the Contract Documents and all adjustments or replacement of defective electrical equipment in the new system completed prior to system switchover.

c) For the testing of circuitry and components, operation of the new signal system shall take place with the covers for the new signal head in place and the existing signal system operational.

d) Signal heads of the existing traffic signal system shall be covered and covers shall be removed from the new signal heads with both systems de-energized. Traffic shall be under police supervision during this operation.

106.07.04.05 Maintenance of Traffic Signal Systems

106.07.04.05.01 General

All routine, non-routine, and emergency maintenance work shall be performed on all traffic signal systems for public use within the limits of the Contract, until the issuance of the Final Acceptance Certificate by the Contract Administrator.

The initial traffic signal timing shall be programmed into the traffic signal controller as directed by the Contract Administrator up to a maximum of four times. The traffic signal controller shall be set up by performing all programming, setting all timing controls and switch settings, and setting any other controller operational parameters obtained from the Contract Administrator. The Contractor shall verify to his own satisfaction that the revised signal timing is consistent and complete.

At any time during the Contract, the Contract Administrator reserves the right to review the timing and operations of the traffic signal system and the Contractor shall implement any changes to the operation settings and timings requested by the Contract Administrator.

All traffic signal system components shall be maintained in good working condition according to the Contract Documents and all routine maintenance and emergency repairs shall be provided as required.

On call local emergency repair service shall be provided 24-7 for the duration of the Contract, including winter shut down. Emergency repairs shall be required whenever there is a failure or cessation of the operation of any component or components of the traffic signal system.

Each time emergency repair work is performed on a traffic signal system, the Contractor shall notify the Contract Administrator within 72 hours of the completion of the emergency repair work.

Any traffic signal timing not included in the original Contract Documents shall be approved by the Owner before it is installed in a traffic signal controller.

Routine, non-routine, and emergency maintenance shall be according to the manufacturer's recommendations and the Owner's maintenance standards.

106.07.04.05.02 Notification and Record Keeping - Traffic Signal Systems

The Contractor shall clearly identify in writing the designated contact person and alternate for liaison with the Contract Administrator. The Contract Administrator shall designate representatives and alternates as contact persons for the Owner.

A logbook shall be maintained and kept in the traffic signal field cabinet or at a location agreed upon with the Owner. The logbook shall record any fieldwork performed on the traffic signal system, including the replacement of any hardware, changes to the software, or changes to the configuration, phasing, or timing parameters. The time and date of each entry in the logbook shall be signed by the individual making the entry.

106.07.04.06 Traffic Signal Activation Meeting

A minimum of 48 hours prior to the planned activation of each set of traffic signals, the Contractor shall coordinate and attend an on-site quality control meeting with the Contract Administrator. As a minimum, the following individuals shall be in attendance at the meeting:

a) Contractor's on-site representative

b) Pavement marking sub-contractor representative

c) Electrical sub-contractor representative

d) Electrical Quality Verification Engineer

e) Contract Administrator

f) Contract Administrator's electrical inspection staff

g) Contractor's person responsible for traffic control and highway work zone safety

h) Owner's electrical coordinator, traffic representative, and electrical quality assurance representative

The purpose of this meeting is to ensure that the Contractor clarifies the roles and responsibilities of all parties involved in the traffic signal activation, that all advanced work is complete, and to confirm that all required arrangements have been made in order to ensure that the activation proceeds smoothly and expeditiously. The Contractor shall prepare the agenda for the meeting and record the minutes to be distributed to all attendees.

As a minimum agenda, the following shall be addressed:

a) General

   i. Confirm the name and position of the person responsible for coordinating traffic control during the signal activation.
   ii. Confirm that arrangements have been made with the appropriate police authority to provide traffic control.
   iii. Confirm that all the work has been constructed as specified in the Contract Documents and is in accordance with the signed legal drawing (PHM-125). Any deficiencies shall be brought to the attention of the Contract Administrator.
   iv. Confirm the date and time of the traffic signal activation.

b) Pavement Marking

   i. Confirm the name and position of the person responsible on site for carrying out the pavement markings.
   ii. Confirm that the pavement markings have been pre-marked as specified in the Contract Documents and are according to the signed legal drawing (PHM-125).
   iii. Review the Contract Drawings for the pavement markings that shall be in place on the day of signal activation.

c) Electrical

   i. Confirm that the Contract Administrator shall be in receipt of all Quality Verification Engineer certificates of conformances immediately following the activation of the signals.
   ii. Confirm that all vehicle detection is positioned as required and functioning correctly.

106.07.05 Maintenance of Highway Lighting Systems

106.07.05.01 General

All routine, non-routine, and emergency maintenance work shall be performed on all highway lighting systems for public use within the limits of the Contract, until the issuance of the Final Acceptance Certificate by the Contract Administrator.

The Contractor shall maintain all lighting systems located within the limits of the Contract in full nighttime operation. The Contractor shall perform all routine, non-routine, and emergency maintenance work required to maintain the lighting systems. Suitable combinations of existing, temporary, or new lighting systems may be used to achieve the required performance, safety, and reliability of the lighting system. The Contractor shall provide routine, non-routine, and emergency maintenance service during winter shut down. Routine, non-routine, and emergency maintenance work shall be according to the Owner's maintenance standards.

106.07.05.02 Notification and Record Keeping - Highway Lighting Systems

The Contractor shall clearly identify in writing the designated contact person and alternate for liaison with the Contract Administrator. The Contract Administrator shall designate representatives and alternates as contact persons for the Owner.

A logbook shall be maintained and kept in the highway lighting system field cabinet or at a location agreed upon with the Owner. The logbook shall record any fieldwork performed on the highway lighting system, including the replacement of any hardware, changes to the software, or changes to the configuration, phasing, or timing parameters. The time and date of each entry in the logbook shall be signed by the individual making the entry.

106.07.06 Temporary Electrical Work

All temporary electrical work specified in the Contract Documents shall be installed and made ready for operation prior to opening the associated traffic lanes or sidewalks that the work is intended to serve.

106.07.07 Layout of Electrical Equipment

All equipment shall be installed at locations detailed in the Contract Documents.

Layout for stations and offsets of concrete pads and footings, electrical chambers, and poles shall not exceed a tolerance of $\pm$ 100 mm.

The Contractor shall ensure there are no Utility conflicts, both overhead and underground, with any pole locations prior to starting any excavation or pole installation work. Underground ducts and cables shall not be located within 600 mm of guide rail.

106.07.08 Adjustment of Electrical Equipment

All luminaires, traffic signal heads, optical lens assemblies, photoelectric controllers, and other devices shall be adjusted according to the Contract Documents. Luminaires shall be adjusted under nighttime operational conditions and in the presence of the Contract Administrator.

106.07.09 Open Excavations

Excavations within 4.0 m of the edge of travelled roadway shall not be left open overnight.

106.07.10 Quality Control

106.07.10.01 General

Tests and inspections on electrical equipment shall be according to the appropriate specifications covering the work.

The Contractor is responsible for all pre-installation and proof of performance testing and inspections for electrical work. Each time the Contractor is to perform an inspection or test, the Contract Administrator shall be notified 48 hours prior to commencing the inspection or test.

106.07.10.01.01 Pre-Installation Testing and Inspection

Pre-installation testing and inspection of electrical work shall include all testing and inspection of system components, including testing of mock-ups, prototype testing, and normal factory production testing undertaken on behalf of the Contractor prior to the installation of such components.

106.07.10.01.02 Proof of Performance Testing and Inspection

Proof of performance testing and inspection of electrical work shall include all testing and inspection of system component installations into the work in order to verify the physical and operational features of each part of the system components and electrical subsystems.

The Quality Verification Engineer shall witness the inspection, testing, and test results for the following electrical work according to the appropriate specification prior to issuing a Certificate of Conformance:

a) Grounding according to OPSS 609.

b) Installation of underpass luminaires according to OPSS 611.

c) Installation of power supply equipment according to OPSS 614.

d) Installation of roadway luminaires according to OPSS 617.

e) Traffic signal equipment and electrical traffic control devices according to OPSS 620.

f) Installation of high mast lighting poles according to OPSS 630.

When issuing the Certificate of Conformance for the above work, the Quality Verification Engineer shall also certify that he or she has witnessed the inspection, testing, and test results for such electrical work.

106.07.10.02 High-Voltage System Testing

All high-voltage cable and electrical equipment shall be tested according to the Contract Documents.

One copy of test results and one copy of the cable and electrical equipment manufacturer's test report shall be submitted to the Contract Administrator.

106.07.11 Documentation

106.07.11.01 General

Documentation, including Working Drawings, catalogue sheets, calculations, drawings, diagrams, test print-outs, photographs, manufacturer's instructions, service manuals, and text shall be provided by the Contractor to a level of detail such that it assures the Contract Administrator that the system components that the Contractor is furnishing are according to the requirements of the Contract Documents. The documentation shall also be used to provide records for future operational and maintenance activities.

The Contractor shall submit, as part of the service manuals, a dated and signed form of inspection of each item of work.

106.07.11.02 Test Results and Inspection Reports

Test results and inspection reports, including any required verifications and certifications from the Quality Verification Engineer, shall be submitted to the Contract Administrator. Inspection reports shall include the completed checklist and any material observations made at the time of the inspection.

The documentation shall include the method of testing and inspecting of each item. The method of testing and inspecting shall ensure that the functional, physical, and environmental aspects of the contract specifications are demonstrated.

The documentation shall include all quantitative information generated as part of the testing and inspecting work, including meter readings, screen displays, charts, and any other numerical or graphical data.

The documentation shall include all applicable verifications and certifications from the Quality Verification Engineer. The documentation shall present the results of all tests and inspections in a format that is logical and easily understood.

Test results and inspection reports shall be submitted to the Contract Administrator within 48 hours of completion of the inspection or test detailing:

a) The installation and operation of the system components on an item-by-item basis.

b) Clear detailed illustrations, including control layouts, displays, schematic diagrams, and all other information, required to correctly operate a fully functional unit as well as the maintenance and service aspects of the system components.

c) The model number, suggested and actual settings, and options as installed and configured for each piece of electrical equipment.

d) Sections that completely describe the theory of operation using block diagrams and schematic drawings.

e) Diagnostic and repair procedures for corrective maintenance of the unit, assembly and disassembly instructions and drawings, layout drawings showing location of all components, and complete components listing showing component type, ratings, cost, and acceptable manufacturers. Complete schematic diagrams to the component level.

f) Fully described adjustments and alignment procedures and provide descriptions of expected signals at all test points and outputs.

g) The specifications of system components performance.

106.07.11.03 Service Manuals

Each service manual shall be assembled in 3-ring binders of 75 mm maximum thickness and shall be indexed item by item. Several items may be covered in a single binder. The manual shall document in detail the installation and operation of the system components on an item-by-item basis. It shall contain clear detailed illustrations, including layout of controls, displays, schematic diagrams, and all other information required to correctly operate a fully functional unit as well as the maintenance and service aspects of the system components. The model numbers, with installed options and installed settings shall be clearly shown.

The manual shall provide sections that completely describe the theory of operation using block diagrams and schematic drawings. The manual shall include diagnostic and repair procedures for corrective maintenance of the unit; assembly and disassembly instructions and drawings; layout drawings showing location of all components; and complete components listing showing component type, ratings, cost, and acceptable manufacturers. Complete schematic diagrams to the component level shall be provided. The manual shall fully describe all adjustments and alignment procedures and provide descriptions of expected signals at all test points and outputs. Detailed specifications of the performance of system components shall be provided.

The Contractor is responsible for generating the required documentation in the event that it is not available from the manufacturer.

The manual shall detail, at the system engineering level, the procedures for installation of software on a given computer system. The manual shall also address the operation of the software at three different levels: beginner (trainee), intermediate (operator), and advanced (systems engineer).

106.07.11.04 Submission of Documentation

The Contractor shall provide the following:

a) Three copies of all documentation required under the Documentation subsection.

b) Three copies of the Working Drawings and service manuals for the items specified in Table 1.

c) Three sets of record drawings to the Contract Administrator at the completion of the Contract. All deviations and design changes from the original design shall be marked accurately on the record drawings printed in red along with any required explanatory notes. The location of the underground facilities on the record drawings shall be drawn accurately and correctly with stations, offsets and tie down points.

d) Three copies of any documents and drawings that are resubmitted.

106.07.11.05 Quality of Documentation

The documentation shall be of professional quality, including machine- or hand-printed text, inked or CAD produced drawings, and photographic material, if applicable.

106.07.12 Restoration

The site of all electrical works shall be restored to original or better condition than existed prior to the works or as specified in the Contract Documents.

106.07.13 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

106.08 QUALITY ASSURANCE

Electrical equipment requiring the submission of Working Drawings, as detailed in the Design and Submission Requirements section is subject to inspection by the Owner's representative prior to shipping of the electrical equipment. The inspection shall take place at the manufacturer's factory or at the supplier's place of business. The Owner's representative shall be informed when the electrical equipment fabrication is approximately 80% and 100% complete and suitable arrangements shall be made for any required inspection.

All electrical work is subject to random inspection by the Owner's representative. The Owner's representative may witness any testing performed by the Contractor.

Upon notification, any Owner's representative (e.g., electrical coordinator, quality assurance representative) shall have access to the working area for the purpose of inspection and testing of electrical installations.

106.10 BASIS OF PAYMENT

Payment at the Contract price for the tender items that require general electrical work shall be full compensation for all labour, Equipment, and Material to do the general electrical work.

When the Contract contains separate tender items for work required by this specification, payment shall be at the Contract prices and according to the specifications for such work.

106.10.01 Contractor's Workers

When the Contract Administrator directs the removal of staff or the cessation of electrical work, no extra payment shall be made by the Owner for any costs incurred by the Contractor as a result of such direction.

106.10.02 Work to be Inspected by Electrical Safety Authority

The work resulting from the inspection or re-inspection of electrical work by the ESA, except for correcting defects that are the direct result of compliance with the Owner's design of the work, shall be at no extra cost to the Owner.

106.10.03 Traffic Signal Systems

The activation of traffic signals, including police supervision, shall be at no extra cost to the Owner.

106.10.04 Maintenance Costs

When the Owner performs maintenance work resulting from inadequate workmanship on systems installed by the Contractor or defective materials supplied by the Contractor, the actual costs of the maintenance work shall be charged to the Contractor.

106.10.05 Temporary Work

Payment for temporary items shall be made at the rate of 80% of the Contract price upon acceptance of the installation, and the remaining 20% of the Contract price shall be paid upon acceptance of the removal work.

TABLE 1
Submission Requirements for Working Drawings and Service Manuals

Item	Submission Requirements	
	Working Drawings	**Service Manuals**
Luminaires	Y	Y
High-voltage switches and fuses	Y	-
Transformers	Y	-
Distribution assemblies	Y	Y
Supply control cabinet assemblies	Y	Y
Traffic signal control cabinet assembly	Y	Y
Anchorage assemblies	Y	-
High mast lighting equipment (i.e., poles, raising and lowering equipment)	Y	Y
High mast luminaires	Y	Y
Advanced traffic management systems equipment	Y	Y
Traffic data collection systems equipment	Y	Y
Roadway weather information systems equipment	Y	Y
Traffic signal controllers	-	Y
Flasher mechanisms	-	Y
Conflict monitors	-	Y
Load switches	-	Y
Loop detectors	-	Y
DC isolators	-	Y
AC isolators	-	Y
Thermostat panel	-	Y

Appendix 106-A, April 2017
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

GENERAL SPECIFICATION FOR THE USE OF EXPLOSIVES

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120-A **Commentary**

120.01 SCOPE

This specification covers the requirements for the use of explosives.

120.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

120.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

120.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Ministry of Transportation Publications

Ontario Traffic Manual (OTM):
Book 7 - Temporary Conditions

Department of Fisheries and Oceans (DFO) Publication

Guidelines for the Use of Explosives in or Near Canadian Fisheries Waters, 1998

International Society of Explosives Engineers (ISEE)

Performance Specifications for Blasting Seismographs, 2011 Edition

120.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Blaster means a competent person knowledgeable, experienced, and trained in the handling, use, and storage of explosives and their effect on adjacent property and persons.

Blast Monitoring Consultant means a consulting engineering firm with a minimum of five years experience related to blasting retained by the Contractor to provide blast monitoring services. The blast monitoring consultant shall be a third party that is not owned or corporately affiliated with the Contractor responsible for the Work.

Consulting Engineering Firm means a firm or an individual that has been issued a Certificate of Authorization and a Consulting Engineer designation by the Professional Engineers Ontario.

Designated Blast Area means the area where the Contractor has notified, in writing, and provided information to all Utilities, public and private property owners, and as the area where the Contractor has made arrangements to evacuate all persons whose safety might be threatened by the blasting operation.

Fish Habitat means as defined by the Fisheries Act.

Flyrock means rock that becomes airborne as a direct result of a blast.

NAV CANADA means the company that owns and operates Canada's civil air navigation service (ANS).

Peak Particle Velocity (PPV) means the maximum component velocity in millimetres per second that ground particles move as a result of energy released from explosive detonations.

Pre-Blast Survey means a detailed record, accompanied by film or video as necessary, of the condition of private or public property, prior to the commencement of blasting operations.

120.04 DESIGN AND SUBMISSION REQUIREMENTS

120.04.01 Design Requirements

A blast design shall be prepared by an individual or firm with a minimum five years experience and be certified by an Engineer. The blast design shall include, as a minimum, the following:

a) Design PPV and design peak sound pressure level at 250 m radius or nearest Utility, residence, structure, or facility.

b) Number, pattern, orientation, spacing, size, and depth of drill holes.

c) Collar and toe load, number and time of delays, and mass and type of charge per delay.

d) Setback distances to affected fish habitat.

e) The explosive products to be used.

f) The designated blast area.

120.04.02 Submission Requirements

The following shall be submitted to the Contract Administrator:

a) A minimum of two weeks prior to the use of explosives:

   i. The name and statement of experience of the firm carrying out the blasting.
   ii. The name of the blaster including a record of experience and safety training.
   iii. The name of the individual or firm responsible for the blast design, including a record of experience and statement of qualifications.
   iv. A letter from an Engineer certifying the design.
   v. The name of the blast monitoring consultant, including a record of experience and a record of qualifications.
   vi. A certificate of insurance indemnifying the Owner from all claims and damages arising from the use of explosives.

b) A minimum of 48 hours prior to the use of explosives:

   i. A letter signed by the Engineer certifying the blast design indicating the areas for which the blast design has been completed.
   ii. A letter signed by the blaster indicating receipt of the blast design and agreement that the blasting shall be according to the design.
   iii. A letter signed by the Contractor certifying that a pre-blast survey has been carried out in accordance with the Pre-Blast Survey subsection and a copy of the pre-blast survey.
   iv. A copy of the blast design, including all items shown in the Design Requirements subsection.
   v. The designated blast area.
   vi. A blasting schedule.
   vii. A list of all locations to be monitored.
   viii. Proof of calibration of all monitoring equipment.

c) Upon request, any blasting permits, approvals, and agreements required for the use of explosives or to carry out blasting operations.

120.05 MATERIALS

120.05.01 Explosives

Only explosive products approved for use in Canada shall be used.

120.06 EQUIPMENT

120.06.01 Detonation Apparatus

Detonation apparatus shall be of the type approved by the detonation system manufacturer for the type of blasting operation to be undertaken. All apparatus shall be kept in working order and shall be thoroughly inspected before and after each blasting operation.

All wiring connected to electrical detonation apparatus shall be properly insulated.

120.06.02 Monitoring Equipment

All monitoring equipment shall be capable of measuring and recording ground vibration PPV up to 200 mm/s in the vertical, transverse, and radial directions. The equipment shall have been calibrated within the last 12 months either by the manufacturer or other qualified agent. Proof of calibration shall be submitted to the Contract Administrator prior to commencement of any monitoring operations.

Monitoring equipment shall be according to ISEE Performance Specifications for Blasting Seismographs.

120.07 CONSTRUCTION

120.07.01 General

Blasting shall be carried out only during daylight hours and at a time when atmospheric conditions provide clear observation of the blast when practical from a minimum distance of 1,000 m. Blasting shall not be conducted on Sundays, statutory holidays, or during electrical storms.

Blasting shall not be carried out within 30 m of concrete placed less than 72 hours when the ambient temperature falls below 20 °C or for 36 hours when the ambient temperature is continuously greater than 20 °C, unless otherwise authorized by the Contract Administrator.

Protection of fish and fish habitat shall be according to the Guidelines for the Use of Explosives in or Near Canadian Fisheries Waters.

120.07.02 Radio-Frequency Hazards

Prior to blasting, investigations shall be done to determine if radio-frequency hazards exist. When such hazards exist, necessary precautions shall be taken.

120.07.03 Pre-Blast Survey

A pre-blast survey shall be prepared for all buildings, Utilities, structures, water wells, and facilities likely to be affected by the blast according to Table 1 where explosives are to be used. The standard inspection procedure shall include the provision of an explanatory letter to the owner or occupant and owner with a formal request for permission to carry out an inspection.

The pre-blast survey shall include, as a minimum, the following information:

a) Type of structure, including type of construction and if possible, the date when built.

b) Identification and description of existing differential settlements, including visible cracks in walls, floors, and ceilings, including a diagram, if applicable, room-by-room. All other apparent structural and cosmetic damage or defect shall also be noted. Defects shall be described, including dimensions, wherever possible.

c) Digital photographs or digital video or both, as necessary, to record areas of significant concern.

Photographs and videos shall be clear and shall accurately represent the condition of the property. Each photograph or video shall be clearly labelled with the location and date taken.

A copy of the pre-blast survey limited to a single residence or property, including copies of any photographs or videos that may form part of the report shall be provided to the owner of that residence or property, upon request.

120.07.04 Notification

120.07.04.01 General

A minimum of 15 Business Days prior to blasting, the Contractor shall provide written notice to Utilities and all owners and tenants of improved property within 250 m of the right-of-way in the vicinity of the blast. The notice shall include a blasting schedule, information about the audible blast warning system, and contact name for questions or other concerns.

The Contractor shall ensure that a competent person is available to receive, document, and deal with public inquiries before and after blasting operations.

A minimum 48 hours prior to blasting, sufficient detail regarding the blasting operations shall be provided to NAV CANADA and the Contract Administrator.

120.07.04.02 Utilities

Authorities of all likely affected Utilities shall be notified a minimum of 72 hours prior to blasting.

120.07.04.03 Properties

Not more than five Business Days and not less than four hours prior to each blast, the Contractor shall provide notice of the blasting schedule to all owners and tenants of buildings or facilities within 150 m of the blast. All blasts scheduled for the following seven Days may be included in one notice. The notice shall include information about the audible blast warning system.

When blasting operations may incur property damage or require temporary evacuation, notification shall include evacuation information and instructions. The Contractor shall take all reasonable steps to ensure that the property owner acknowledges, by their signature, that they have received the information and shall comply with any evacuation requirements. When such signature is withheld, the Contractor shall maintain records showing the date and time that the information was delivered.

120.07.05 Monitoring

120.07.05.01 General

The Contractor shall employ a blast monitoring consultant to carry out monitoring for PPV, peak sound pressure levels, and water overpressures as required. During each blast, ground vibration PPV and the peak sound pressure level shall be monitored at 250 m from the area of the blast or at the closest portion of any Utility, residence, structure, or facility. Water overpressure in affected fish habitats shall be monitored adjacent to the shore closest to the blast. The monitoring equipment shall be repositioned as required.

120.07.05.02 Ground Vibration

Ground vibration as measured by PPV shall be limited to the maximum levels shown in Table 2. Should readings from any two consecutive blasts exceed these values or any single reading exceed these values by more than 30 mm/s, the blast operation shall cease until a revised blast design, certified by the Engineer, has been submitted to the Contract Administrator.

120.07.05.03 Water Overpressure

Instantaneous pressure change as measured by water overpressure in or near fish habitat shall not exceed 100 kPa.

120.07.05.04 Trial Blasts

The Contractor shall confirm the suitability of the blast design for the ground vibration PPV limits and sound pressure levels by carrying out a minimum of three limited test blasts at locations agreed upon by the Contract Administrator and the Contractor. The trial blasts shall be carried out with appropriate blast vibration and noise level monitoring equipment. Based on the results, the initial blast design shall be revised as necessary.

120.07.06 Protective Measures

Immediately prior to the blast, the designated blast area shall be cleared of all vehicular and pedestrian traffic.

All traffic shall be stopped and prevented from entering the area until the blaster gives permission. Traffic control shall be according to the Ontario Traffic Manual, Book 7. Signs shall be posted to inform the public of blasting operations and to turn off radio transmitters. Audible blast warning devices, capable of alerting workers and the public up to a radius of 1,000 m, shall be used before and after blasting.

Blasting mats or other suitable means of controlling flyrock shall be used to limit potential hazardous effects of the blast.

120.07.06.01 Protection of Utility Lines

Where temporary rearranging and shielding of utility lines are detailed within the Contract Documents, such temporary rearranging and shielding is the minimum protection required. The Contractor shall remain responsible for any unauthorized disruptions of service and any damage to utilities arising out of the Contractor's work, notwithstanding such protection. The Utility authorities shall carry out the temporary rearranging and shielding of lines as detailed within the Contract Documents and more extensive rearranging and shielding if requested to do so by the Contractor. The cost of all such protective measures, together with the cost of restoring the lines to their original state and location, shall be at the expense of the Contractor, and shall be billed to the Contractor by the Utility authority.

Notwithstanding the preceding paragraph, the Utility authorities shall, subject to the Contractor's obligation under the Contract to assume responsibility for disruption of services and damage, consider alternative measures which the Contractor may suggest. Such alternative measures, if approved by the Utility authorities in writing, shall be provided at the Contractor's expense and billed to the Contractor by the Utility authority.

Whenever, in the opinion of the Utility authority, standby crews are necessary during blasting operations, the Contractor shall make the necessary arrangements with the Utility authority and the cost of such crews and equipment shall be billed to the Contractor by the Utility authority. These measures shall apply to those utilities located within all rock blasting areas.

120.07.07 Records

A post-blast record shall be prepared and signed by the blaster for each blast completed. The post-blast record shall report the following conditions and be made available to the Contract Administrator for site review:

a) The date, time, and location of the blast.

b) The wind direction and approximate speed at the time of the blast.

c) The general atmospheric conditions at the time of the blast.

d) The actual blast details.

e) PPV, peak sound pressure level, and water overpressure results of each blast.

A report summarizing the results of the ground vibration and peak sound pressure levels shall be submitted to the Contract Administrator at the end of each work day that blasting was carried out.

120.07.08 Damage

Upon completion of blasting or immediately following the receipt of a complaint, a site condition survey shall be performed to determine if any damage has resulted. The Contractor shall record all incidents of any damage or injury, which shall be reported immediately in writing to the Contract Administrator. All other complaints shall be reported to the Contract Administrator in writing within 24 hours of receipt. Each complaint report shall include the name and address of the complainant, time received, and description of the circumstances that led to the complaint.

120.07.09 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

120.10 BASIS OF PAYMENT

Payment at the Contract price for the appropriate tender items that requires the use of explosives shall be full compensation for all labour, Equipment, and Material to do the work.

When the Contract contains separate items for work required by this specification, payment shall be at the Contract prices and according to the specifications for such work.

The cost of standby crews and equipment required by Utility authorities shall be the responsibility of the Contractor.

120.10.01 Claims

The Contractor shall be responsible for the management of all claims and payment arising from the hauling, handling, use of, and storing of explosives and all effects, directly or indirectly related to the blasting operation.

TABLE 1
Radius of Pre-Blast Survey

Depth of Rock Excavation	Radius of Pre-Blast Survey from Blast Site
< 5 m	75 m
≥ 5 – 10 m	150 m
> 10 m	150 m If no buildings exist within 150 m, the closest building within 500 m

TABLE 2
Maximum Peak Particle Velocity Values

Element	Frequency Hz	Peak Particle Velocity (PPV) mm/s
Structures and Pipelines	≤ 40	20
	> 40	50
Concrete and Grout < 72 hours from placement	N/A	10

Appendix 120-A, November 2019
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

This specification should be included on all projects that require the use of explosives.

The designer should determine if Utility authorities have any special measures or minimum offset distances and include them in the Contract Documents.

The designer should identify if there are site-specific conditions or environmental issues that may affect blasting design and alter monitoring requirements, pre-blast survey limits, pre-blast survey requirements, or notification limits as necessary, and include them in the Contract Documents.

The designer should provide names of Utility authorities and contacts involved in the Contract.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

GENERAL SPECIFICATION FOR THE MANAGEMENT OF EXCESS MATERIALS

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180.08 **QUALITY ASSURANCE - Not Used**

180.09 **MEASUREMENT FOR PAYMENT - Not Used**

180.10 **BASIS OF PAYMENT**

APPENDICES

180-A **Commentary**

180.01 SCOPE

This specification covers requirements for the management of excess materials.

Where the management of excess material requirements of other Ontario Provincial Standard Specifications differs from this specification, the requirements of this specification will take precedence.

180.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

180.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

180.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 206 Grading
OPSS 209 Embankments Over Swamps and Compressible Soils

Ontario Provincial Standard Specification, Material

OPSS 1004 Aggregates, Miscellaneous

Canadian and Provincial Statutes

Environmental Protection Act, R.S.O. 1990, c.E.19 & R.R.O. 1990, Regulation 347
GENERAL - WASTE MANAGEMENT
As amended

Transportation of Dangerous Goods Act, 1992,
S.C. 1992, c. 34

Fire Protection and Prevention Act, 1997
S.O. 1997, CHAPTER 4

Provincial Statute

O. Reg 406/19 On-Site and Excess Soil Management made under the Environmental Protection Act, R.S.O. 1990, c.E.19

Ministry of the Environment, Conservation and Parks (MECP) Publications

Rules for Soil Management and Excess Soil Quality Standards

180.03 DEFINITIONS

For the purpose of this specification, the definitions in OPSS 182 and the following definitions apply:

Bituminous Pavement means any combination of asphaltic material and aggregate, excluding asbestos modified asphaltic material.

Commercial Waste means as defined in Regulation 347, under the Environmental Protection Act, Ontario.

Concrete means concrete mixtures produced with Portland cement and may include blended hydraulic cement, supplementary cement materials, spent debris and silica sand abrasive blasting media from abrasive cleaning of concrete and reinforcing steel, and concrete brick and block and associated mortar. It may include embedded steel and excludes asbestos modified Portland cement concrete mixtures.

Disposable Fill means excess material other than that disposed of at a certified disposal site and that is managed in berms and mounds and as fill other than in road embankments.

Earth means as defined in OPSS 206.

Excess Soil means as defined in O. Reg 406/19 On-Site and Excess Soil Management.

Excess Soil Standards means as defined in O. Reg 406/19 On-Site and Excess Soil Management.

Excess Material means material removed under the Work specified in the Contract Documents for which management is not specified and includes surplus and unsuitable materials.

Ground Water means subsurface water and water that occurs beneath the water table in soils and rock formations that are fully saturated.

Manufactured Wood means wood that is not entirely natural wood.

Masonry means clay brick and associated mortar.

Natural Wood means stumps, trunks, branches, debris from tree and shrub removal, and wood products that are not treated, coated, or glued.

Non-Hazardous Solid Industrial Waste means as defined in Regulation 347, under the Environmental Protection Act, Ontario.

Qualified Person means as defined in O.Reg 406/19 On-Site and Excess Soil Management.

Re-Use means using, processing, re-processing, or recycling of excess material into a construction material or other useful product and managed by these means for the Contract and other work.

Reuse Site means as defined in Rules for Soil Management and Excess Soil Quality Standards.

Rock means as defined in OPSS 206.

Salt-Impacted means materials that have concentrations of chloride and sodium and values for electrical conductivity and sodium adsorption ratio that could impact the growth of certain types of plants.

Subject Waste means as defined as in Regulation 347, under the Environmental Protection Act, Ontario.

Swamp Material means as defined in OPSS 209.

Waste means excess material that is not managed by re-use, open burning, or as disposable fill and includes any excess material.

180.04 DESIGN AND SUBMISSION REQUIREMENTS

180.04.01 Submission Requirements

180.04.01.01 Notification of Site Selection, and Property Owner Release

A copy of the completed form OPSF 180-1, Site Selection Notification for Stockpiling Materials Managed Through Re-Use, or OPSF 180-2, Site Selection Notification for Material Managed as Disposable Fill or both shall be submitted to the Contract Administrator and the property owner at least 2 weeks prior to the use of the property. These forms are not required for property owned by the Owner or designated for use in the Contract Documents.

At the completion of such work, a completed copy of the form OPSF 180-3, Property Owner's Release, shall be provided to the Contract Administrator.

The Contractor shall be responsible for any sampling and testing necessary to comply with any requirements imposed by a property owner as a condition of accepting excess material.

180.04.01.02 Verification of Management by Disposal as Non-Hazardous Solid Industrial or Commercial Waste

When excess material is managed by disposal as non-hazardous solid industrial or commercial waste, a copy of the weigh ticket or receipt provided by the disposal site operator shall be submitted to the Contract Administrator on a weekly basis. When such documentation is not available, written confirmation that the waste has been received shall be obtained from the operator of the disposal site and provided to the Contract Administrator within 2 weeks after disposal activities are complete.

Within 3 weeks of the completion of all disposal activities associated with the work, a completed copy of the OPSF 180-5, Waste Quantity Report, shall be provided to the Contract Administrator and shall account for all excess material managed by disposal as solid non-hazardous industrial or commercial waste.

180.04.01.03 Notification of Forest Resource Licensees

Forest Resource licensees identified in the Contract Documents shall be notified at least 2 weeks prior to commencement of open burning.

180.04.01.04 Environmental Compliance Approval

When Environmental Compliance Approval(s)/Certificates of Approval for a Waste Management System or a Waste Disposal Site are required, a copy of such approval shall be supplied to the Contract Administrator prior to transporting excess material or waste from the Working Area.

180.04.01.05 Subject Waste Documentation

For each subject waste listed in the form OPSF 180-4, Subject Waste Classification, that is being shipped from the Working Area to a waste disposal site, the following shall be completed:

a) The Contract Administrator shall be notified at least 2 weeks prior to the first shipment of subject waste, and at least 24 hours prior to each subsequent shipment of subject waste.

b) A Regulation 347 manifest with Part B completed by the carrier for each truckload of subject waste, shall be submitted to the Contract Administrator for Part A completion. Copies #1 and #2 of the manifest with Part A and B completed shall be retained by the Contract Administrator and the remaining copies #3 to #6 returned to the carrier.

c) Copy #6 of the Regulation 347 manifest shall be forwarded to the Contract Administrator at the mailing address indicated on Part A of the manifest, within 4 weeks of the shipment of subject waste from the Working Area.

For each subject waste that is generated by the Contractor's operations and that is not listed in form OPSF 180-4, Subject Waste Classification that is being shipped from the Working Area to a waste disposal site, the following documentation shall be provided to the Contract Administrator.

a) Prior to shipment of the subject waste:

   i. Test results from testing to determine the Regulation 347 waste class and characteristics of the subject waste from the Canadian Association for Laboratory Accreditation (CALA) accredited laboratory selected by the Contractor;
   ii. Notification from the MECP Hazardous Waste Information Network (HWIN) of the registration of the subject waste to obtain a Regulation 347 Generator Registration Number (GRN); and
   iii. A duplicate of Copy #2 of the Regulation 347 manifest with Parts A and B completed and signed by the generator and carrier respectively.

b) After shipment of the subject waste:

   i. Notification of payment of all registration, manifest, and tonnage fees associated with the shipment from the MECP HWIN;
   ii. A duplicate of Copy #6 of the Regulation 347 manifest with Part C completed and signed by the receiver; and
   iii. Notification of de-activation of the Regulation 347 GRN in the MECP HWIN.

A record of all test sample numbers and sample dates shall be kept and made available to the Contract Administrator upon request.

180.04.01.06 Excess Material Audit or Inventory Document

When an excess material audit or inventory is imposed by statute or is a condition specified in the Contract Documents, a copy of the audit or inventory documents shall be provided to the Contract Administrator.

180.04.01.07 Alternative Management Condition Approvals

When certain excess material is to be managed according to the conditions approved in writing by the local district office of MECP and such conditions differ from those specified in Table 1, a copy of such approval shall be provided to the Contract Administrator at least 2 weeks prior to commencement of the work governed by the condition.

180.04.01.08 Excess Soil Reuse Plan

A minimum of 14 Days prior to commencing the removal of excess earth from the Working Area, an excess soil reuse plan shall be submitted to the Contract Administrator for excess earth subject to the requirements of O. Reg. 406/19 and Rules for Soil Management and Excess Soil Quality Standards, for information purposes only. Generic excess soil quality standards are specified in Table 3. When required, the services of a qualified person shall be retained according to O.Reg 406/19.

The excess soil reuse plan shall include the following information for each reuse site:

a) The municipal address (if applicable), latitude and longitude, in NAD83 or WGS84 coordinate system, and description of the reuse site;

b) The property use of the reuse site and any characteristics associated with the reuse site or nearby properties that may affect the excess soil quality standards applicable to the reuse site;

c) A description of the undertaking or the identified beneficial purpose for which the excess soil is to be reused;

d) The estimated quantity of excess soil, including any salt impacted quantities, to be managed at the reuse site and that are necessary for the identified beneficial purpose;

e) The applicable excess soil quality standards for the reuse site, as determined according to:

   i. the excess soil standards, and/or;
   ii. the site-specific excess soil quality standards developed, in accordance with the Rules for Soil Management and Excess Soil Quality Standards, for the reuse site according to the Beneficial Reuse Assessment Tool (BRAT) available on the Government of Ontario website;

f) Documentation showing that appropriate landowner consultation and disclosure has taken place and confirmation of the site owner's / operator's written consent to accept the excess soil;

g) Completed copies of OPSF 180-1 and/or OPSF 180-2;

h) If the reuse site is or will be governed by a site-specific instrument, identify the instrument, the public body responsible for issuing the instrument and any other information relevant to the reuse of excess soil at that site; and

i) The record keeping/tracking system to be employed, according to the Rules for Soil Management and Excess Soil Quality Standards as applicable, to track excess earth movements during its transportation and placement at the reuse site.

180.07 CONSTRUCTION

180.07.01 Conditions on Management of Excess Material - General

Management of excess material shall be as described in Tables 1 and 2 and the appropriate subsections of this specification unless prior alternative management conditions are approved in writing by MECP.

When an excess material is a mixture of materials, it shall be managed in compliance with the most stringent conditions associated with any of the constituent excess material.

When excess material includes asbestos waste, the asbestos waste shall be managed as specified in the Contract Documents.

Excess materials shall not be permitted in waterbodies and sensitive areas as identified in the Contract Documents, except when re-used according to the appropriate specification.

Excess earth may contain elevated concentrations of chloride and sodium and may have elevated values for electrical conductivity and sodium adsorption ratio. For the purpose of this Contract, excess earth with salt impacts is not considered to be "contaminated" within the meaning of Table 1. Possible salt impacts and applicable legislative requirements shall be considered when excess earth is managed as disposable fill, by stockpiling, or by re-use.

180.07.02 Conditions on Management by Re-Use

Management of excess material by re-use for incorporation into the work or for other designated re-use shall be as specified in the Contract Documents. Management by re-use shall otherwise be outside the Owner's property. Distance separations described in Table 2 do not apply for the following:

a) Re-use of excess materials for the same purpose.

b) Re-use of bituminous pavement, concrete, and masonry within a road right-of-way.

c) Re-use of concrete as aggregate in bituminous pavement.

d) Re-use of concrete as rip-rap, gabion stone, or rock protection in compliance with the requirements of OPSS 1004.

Except cutting for construction purposes, excess material consisting of manufactured wood shall not be reprocessed.

180.07.03 Conditions on Management as Disposable Fill

Management of excess material as disposable fill, including sidecasting of swamp material, within the Owner's property and on other property designated in the Contract Documents shall be as specified in the Contract Documents.

Natural wood and debris from open fires may be managed as disposable fill only within a road right-of-way or on property with a boundary common to a road right-of-way, both within the Contract limits.

Such material shall be top covered by at least 300 mm of earth or topsoil.

180.07.04 Conditions on Management by Open Burning

Management of excess material by open burning is permitted only when specified in the Contract Documents. Where management by open burning is permitted, it shall be subject to the following conditions and conducted in accordance with the Fire Protection and Prevention Act, 1997 where it applies, and with any applicable, local, municipal by-law(s):

a) A permit from the Ministry of Natural Resources and Forestry (MNRF) under the Fire Protection and Prevention Act, and/or applicable local or municipal by-law shall be obtained by the Contractor for open burning, as required.

b) Open burning is prohibited in areas subject to a restricted fire zone order as issued by MNRF or to a smog alert advisory as issued by MECP.

180.07.05 Conditions on Management by Disposal as Non-Hazardous Solid Industrial or Commercial Waste

Management of excess material by disposal as non-hazardous solid industrial or commercial waste at receiving sites designated in the Contract Documents shall be as specified in the Contract Documents.

When receiving sites are not specified in the Contract Documents for management by disposal as non-hazardous solid industrial or commercial waste, such material shall be disposed of at sites identified by the Contractor.

Non-hazardous solid industrial or commercial waste shall be transported from the Working Area directly to a site that has an Environmental Compliance Approval/ Certificate of Approval for a Waste Disposal Site that is valid for non-hazardous solid industrial or commercial waste.

180.07.06 Conditions on Management by Stockpiling

Management of excess material by stockpiling within the Owner's property and on other property designated in the Contract Documents shall be as specified in the Contract Documents.

Stockpiling shall otherwise be outside the Owner's property.

Stockpiles of bituminous pavement, concrete, and masonry shall be separated according to Table 2 unless either of the following occurs:

a) Stockpiles are located within a road right-of-way or on property with a boundary common to a right-of-way, both within the Contract limits for a period not exceeding 120 Days.

b) Stockpiles are located within a provincial or municipal works yard or in a commercially licensed pit or quarry.

For all other excess materials, where Table 1 indicates that stockpiling is subject to management conditions in Table 2, such management conditions only apply to stockpiles that are to be in place for a period exceeding 120 Days.

180.07.07 Conditions on Management by Disposal as Subject Waste

When an excess material is identified as a dangerous good waste or a subject waste in form OPSF 180-4, Subject Waste Classification, management shall be as follows:

a) Subject waste shipments shall be manifested and transported directly to a certified waste disposal site.

b) When the subject waste is also a dangerous good as described in the Transportation of Dangerous Goods Act (TDGA), the carrier shall provide all necessary TDGA labels and placards.

When an excess material generated by the Contractor’s operations may be subject waste and it is not identified in form OPSF 180-4, Subject Waste Classification, the Contractor shall be responsible to manage it in accordance with the following:

a) Conduct sampling and testing using a laboratory certified by the Canadian Association of Laboratory Accreditation (CALA) selected by the Contractor to determine whether it is subject waste and to determine the Regulation 347 waste class and characteristics.

b) Register all subject waste in the MECP HWIN and obtain a Regulation 347 GRN for disposal.

c) Package and label all subject waste for transportation and disposal.

d) Arrange for shipment of all subject waste to a certified waste disposal site using a certified carrier.

e) Complete Part A of a Regulation 347 manifest including the GRN obtained from the MECP HWIN and provide the manifest to the certified carrier for completion of Part B.

f) Provide a duplicate of Copy #2 of the Regulation 347 manifest to the Contract Administrator with Parts A and B completed and signed.

g) Pay all registration, manifest and tonnage fees associated with subject waste disposal in the MECP HWIN.

h) De-activate the GRN in the MECP HWIN after shipment of all subject waste to a certified waste disposal site is complete and acceptance of the subject waste is acknowledged by the receiver completing and signing Part C of the Regulation 347 manifest.

i) Provide a duplicate of Copy #6 of the Regulation 347 manifest to the Contract Administrator upon receipt from the receiver.

When an excess material is tested and found not to be a dangerous good waste or a subject waste, it shall be managed according to the Verification of Management by Disposal as Non-Hazardous Solid Industrial or Commercial Waste clause.

180.07.08 Excess Earth Quantity Report

A completed form OPSF 180-6, Excess Earth Quantity Report, shall be submitted to the Contract Administrator not less than 3 Business Days prior to all regularly scheduled site meetings, for information purposes only. The submittal shall account for all excess earth managed as disposable fill, by stockpiling, and by re-use. Revisions shall be highlighted. The form shall confirm the submission date of the corresponding Notification of Site Selection and Property Owner Release forms to the Contract Administrator. A final completed Quantity Report Form OPSF 180-6, shall be submitted to the Contract Administrator prior to Contract Completion, for information purposes only.

180.07.09 Verification of Excess Soil Reuse Plan

Within 14 Days of the completion of the excess soil reuse plan, a report including records shall be submitted to the Contract Administrator, verifying that excess soil has been placed to the correct reuse site(s) for the quantity and the beneficial purpose identified in the excess soil reuse plan, as amended, for information purposes only. Amendments to the plan shall be identified in the report.

180.10 BASIS OF PAYMENT

Payment for the management of excess material shall be included in the tender items requiring such management and shall include all costs associated with acquiring approvals, releases, and agreements.

Payment for the management of excess material that is subject waste generated by the Contractor's operations and not listed in form OPSF 180-4 by the Owner, and is in addition to the cost of disposal as non-hazardous, solid industrial, or commercial waste, shall be paid as Extra Work, with provisions subject to testing to verify that the excess material is subject waste.

Table 1
Excess Material Management Conditions

Excess Material Description	Subsection in This Specification				
	Conditions on Management by Re-Use	**Conditions on Management as Disposable Fill**	**Conditions on Management by Open Burning**	**Conditions on Management by Disposal as Non-hazardous Solid Industrial or Commercial Waste**	**Conditions on Management by Stockpiling**
Earth	Yes	Yes	n/a	Yes	Yes
Swamp Material	Yes	Yes Table 2	n/a	Yes	Yes Table 2
Aggregate	Yes	Yes	n/a	Yes	Yes
Rock	Yes	Yes	n/a	Yes	Yes
Bituminous Pavement	Yes Table 2	Not Permitted	n/a	Yes	Yes
Concrete	Yes Table 2	Not Permitted	n/a	Yes	Yes
Masonry	Yes Table 2	Not Permitted	n/a	Yes	Yes
Manufactured Wood	Yes	Not Permitted	Not Permitted	Yes	Yes Table 2
Natural Wood	Yes	Yes Table 2	Yes	Yes	Yes Table 2
Debris From Open Fires	n/a	Yes Table 2	n/a	Yes	Yes Table 2
Metal/Plastic Polystyrene Products	Yes	Not Permitted	Not Permitted	Yes	Yes
Subject Waste	Subject waste shall be managed as specified in the subsection for Conditions on Management by Disposal as Subject Waste.				
Materials Suspected of Being Contaminated	When excess materials that were not generated by the Contractor's operations and are not listed in form OPSF 180-4, Subject Waste Classification, are suspected of being contaminated, direction on their management shall be obtained from the Contract Administrator.				
Other Materials	Excess materials that are not listed above shall be managed as specified in the subsection for Conditions on Management by Disposal as Non-Hazardous Solid Industrial or Commercial Waste, unless prior alternative management conditions are approved in writing by the Ministry of Environment, Conservation and Parks.				

Table 2
Excess Material Management Distance Separation Requirements

Adjacent Feature	Minimum Distance Separation
Ground Water	2 m (Above)
Waterbodies	30 m
Water Wells	100 m
Residences	100 m

SITE SELECTION NOTIFICATION FOR STOCKPILING MATERIALS MANAGED THROUGH RE-USE

Contract Information

Contract No: _____ Owner: _____

The following describes the notification process between the Owner of the Contract and the Contractor, wherein the Contractor formally notifies the Owner that agreement has been reached with a third party property owner for the stockpiling of Contract generated excess material. Such excess material, stockpiled for re-use or disposal, may be one or a combination of: earth; aggregate; swamp material; rock; concrete; masonry; bituminous pavement; natural wood; metal, plastic, and polystyrene; wood which has been treated, coated, or glued; and debris from open fires, provided the conditions on management are satisfied.

Site Information

Registered Property Owner(s) for the subject property: _____

The subject property use description:_____

Lot _____ , Concession _____ , Township of _____

County/Region/District of _____

Quantity (tonnes/cubic metres) and Type of Excess Material stockpiled: _____

_____

This is to notify you, as Owner, that permission has been obtained from the property owner(s) named herein for the management of excess materials through re-use from this Contract. The property owner has signed and been provided with a copy of this form and has been advised that the Site Selection Notification for Material Managed as Disposable Fill Form, OPSF 180-2 (for excess soil management), and a Property Owner's Release Form, OPSF 180-3, will also be required. The use of this management site will comply with the following:

Conditions on Management

It is understood that materials are stockpiled to be re-used or held for disposal at a certified waste disposal site. Stockpiles of natural wood, manufactured wood, debris from open fires, and swamp material may only be located:

a) A minimum of 2 m above the level of ground water.
b) A minimum of 30 m from waterbodies.
c) A minimum of 100 m from any water wells.
d) A minimum of 100 m from residences.

Stockpiles of bituminous pavement, concrete, and masonry may only be located:

a) A minimum of 30 m from waterbodies; and
b) A minimum of 100 m from residences unless
    1. on property with a boundary common to a right-of-way, within the contract limits for a period not exceeding 120 calendar days, or
    2. such stockpiles are located within a provincial or municipal works yard or in a commercially licensed pit or quarry.

I/We state that I/we are the registered owner(s) of the property identified above and I/we agree to sign the Property Owner's Release after the Contractor has placed the excess material on the above-noted property in accordance with the terms of this form.

These conditions do not supersede any constraints imposed on this property by Federal, Provincial or Municipal, including Conservation Authority, statute or regulations and bylaws made thereto.

Dated this _____ day of _____ 20____

_____	_____
Print Contractor's Name & Field Representative's Name	Contractor's Field Representative Signature
_____	_____
Print Registered Property Owner's Name (s)	Registered Property Owner's Signature(s)

cc: Contract Administrator, Property Owner(s), Contractor

SITE SELECTION NOTIFICATION FOR MATERIAL MANAGED AS DISPOSABLE FILL

Contract Information

Contract No: _____ Owner: _____

The following describes the notification process between the Owner of the Contract and the Contractor, wherein the Contractor formally notifies the Owner that agreement has been reached with a third-party property owner for the disposition of Contract generated excess material. Such excess material, managed as disposable fill, shall be limited to one or a combination of: earth, aggregate, swamp material, rock, natural wood, and debris from open fires, provided the conditions on management are satisfied.

Site Information

Registered Property Owner(s) for the subject property: _____

The subject property use description: _____

Lot _____, Concession _____, Township of _____

County/Region/District of _____

Quantity (tonnes/cubic metres) and Type of Excess Material stockpiled: _____

_____

For Excess Soil Management

A description of the beneficial purpose for which the Excess Soil is to be reused at this site:

_____

The Excess Soil Quality Standards that apply to this site:

_____

Confirmation that Excess Soil Quality Standards applicable to this site align with the quality of excess soil to be brought to this site:

_____

This is to notify you, as Owner, that permission has been obtained from the property owner(s) named herein for the management of excess materials from this Contract. The property owner has signed and been provided with a copy of this form and has been advised that a Property Owner's Release Form, OPSF 180-3, will also be required. The use of this management site will comply with the following:

Conditions on Management

Swamp material, natural wood, and debris from open fires managed as disposable fill will be top covered by a minimum of 300 mm of earth or topsoil. Swamp material, natural wood, and debris from open fires managed as disposable fill may only be placed:

a) A minimum of 2 m above the level of ground water.
b) A minimum of 30 m from waterbodies
c) A minimum of 100 m from any water wells
d) A minimum of 100 m from residences.

Salt-Impacted Excess Soil may only be placed:

a) Where it is reasonable to expect that the soil will be affected by the same chemicals as a result of continued application of a substance for the safety of vehicular or pedestrian traffic under conditions of snow or ice; or
b) With an industrial or commercial property use and to which non-potable water standards would be applicable; or
c) That is at least 1.5 m below the surface of the soil.

Salt-Impacted Excess Soil shall not be finally placed:

a) Within 30 m of a waterbody;
b) Within 100 m of a potable water well or area with an intended property use that may require a potable water well; or
c) In lands that will be used for growing crops or pasturing livestock unless the excess soil is placed 1.5 m or greater below the soil surface.

I/We state that I/we are the registered owner(s) of the property identified above and I/we agree to sign the attached form of Property Owner's Release after the Contractor has placed the excess material on the above-noted property in accordance with the terms of this form.

These conditions do not supersede any constraints imposed on this property by Federal, Provincial, or Municipal, including Conservation Authority, statute or regulations and bylaws made thereto.

Dated this _____ day of _____ 20____

_____	_____
Print Contractor's Name & Field Representative's Name	Contractor's Field Representative Signature
_____	_____
Print Property Owner's Name(s)	Registered Property Owner's Signature(s)

cc: Contract Administrator, Property Owner(s), Contractor

PROPERTY OWNER'S RELEASE

Contract No: _____

Work Description: _____

_____

I/We _____ being the owner(s) of Lot, _____

Concession _____, Township of _____, and County/Region/District of _____, verify that the Contractor for the above noted work has placed excess material from the above noted Contract on my/our property with my/our permission. I/We have signed together with the Contractor forms OPSF 180-1, Site Selection Notification for Stockpiling Materials Managed Through Re-Use, or OPSF 180-2, Site Selection Notification for Material Managed as Disposable Fill, or both, that describe Conditions on Management, and have been assured by the Contractor that these conditions have been met.

Quantity (tonnes/cubic metres) and Type of Excess Material used as fill:

_____

Where materials are managed as disposable fill, I/we agree to be responsible for any subsequent relocation and management of the material so placed.

Quantity (tonnes/cubic metres) and Type of Excess Material stockpiled:

_____

Where materials are to be stockpiled, I/We agree that the stockpile(s) will be removed by the date(s) herein noted:

_____

For materials managed as Excess Soil, the Quantity (tonnes/cubic metres) and the Identified Beneficial Purpose for which the Excess Soil was reused:

_____

For Salt-Impacted Excess Soil, the Quantity (tonnes/cubic metres) and the Identified Beneficial Purpose for which the Excess Soil was reused:

_____

I/We state that I/we are the registered owner(s) of the property identified above and I/we hereby release the Owner and the Contractor in respect of the activities of the Contractor carried out in accordance with this release.

Dated this _____ day of _____ 20____

_____	_____
Print Registered Property Owner's Name (s)	Registered Property Owner's Signature(s)
_____	_____
Print Contractor's Name & Field Representative's Name	Contractor's Field Representative Signature

cc: Contract Administrator, Property Owner(s), Contractor

SUBJECT WASTE CLASSIFICATION

The following named waste is to be disposed of as a subject waste:

_____

The classification of the above waste is as follows:

Shipping Name of Waste	
Reg. 347 Classification	
TDGA Identification No. (PIN)	
TDGA Classification	
TDGA Packaging Group	
Volume of Waste	
Container Type and Condition	

The following named waste is to be disposed of as a subject waste:

_____

The classification of the above waste is as follows:

Shipping Name of Waste	
Reg. 347 Classification	
TDGA Identification No. (PIN)	
TDGA Classification	
TDGA Packaging Group	
Volume of Waste	
Container Type and Condition	

cc: Contract Administrator, Property Owner(s), Contractor

OPSF 180-4 (November 2016)

This form to be used with Ontario Provincial Standard Specification 180

WASTE QUANTITY REPORT

For Solid Non-Hazardous Industrial and Commercial Waste

Contract No: _____

Contractor: _____

Material Description	Location of Disposal Site and Certificate of Approval Number	Quantity of Materials

cc: Contract Administrator, Property Owner(s), Contractor

OPSF 180-5 (November 2016)

This form to be used with Ontario Provincial Standard Specification 180

Excess Soil Quantity Report

For Excess Soil Managed by Stockpiling, Re-Use and as Disposable Fill

Contract No: _____ Progress Meeting Date: _____

Contract Description: _____

Contractor: _____

Print Name of Person Completing this Form: _____

Signature: _____

Date	Type of Placement S = Stockpiled D = Disposable Fill R = Beneficial Re-use	Location of Material Placement	Estimated Quantity of Material Placed (M^3)	Site Selection Notification Submission Date (Form OPSF 180-1 or OPSF 180-2)	Property Owner's Release Submission Date (Form OPSF 180-3)
Final Quantities		**Stockpiled**		**m^3**	
		Disposable Fill		**m^3**	
		Beneficial Re-use		**m^3**	

Cc: Contract Administrator, Property Owner(s), Contractor

OPSF 180-6 (July 2021)

Appendix 180-A, November 2021
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Property available for stockpiling for re-use and disposable of fill, or management as disposable fill of excess materials. (180.04.01.01)

- Forest resource licensees within the Contract limits. (180.04.01.03)

- Excess material audit or inventory when required. (180.04.01.06)

- Generic excess soil quality standards (Table 3). (10.04.01.8)

- Management conditions of materials with asbestos waste. (180.07.01)

- Identification of waterbodies and sensitive areas. (180.07.01)

- Management by re-use. (180.07.02)

- Management of disposable fill within the Owner's property and on other property. (180.07.03)

- Conditions on management by open burning. (180.07.04)

- Management by disposal of non-hazardous solid industrial or commercial waste. (180.07.05)

- Receiving sites. (180.07.05)

- Management by stockpiling within the Owner's property or on other property. (180.07.06)

- Management of dangerous good waste or subject waste. (180.07.07)

Clauses 180.04.01.01 and 180.04.01.08 require the use of OPSF 180-1 as a Site Selection Notification for Stockpiling Materials Managed Through Re-Use Form, and/or OPSF 180-2 as a Site Selection Notification for Material managed as Disposable Fill. Clause 180.04.01.01 requires the use of OPSF 180-3 as a Property Owner's Release Form. Clauses 180.04.01.05, 180.07.07, 180.10, and Table 1 require the use of OPSF 180-4 as a Subject Waste Classification Form. 180.04.01.02 requires the use of OPSF 180-5 as a Waste Quantity Report Form. Subsection 180.07.08 requires the use of OPSF 180-6 as an Excess Earth Quantity Report. If any form(s) other than OPSF 180-1, OPSF 180-2, OPSF 180-3, OPSF 180-4, OPSF 180-5, or OPSF 180-6 will be used for submission purposes, the alternate form(s) should be invoked by reference in the Contract Documents and the specification should be amended to remove reference to the OPSF(s).

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Table 3
Generic Excess Soil Quality Standards

Township	Station (Offset)	Excavation Depth Range (Note 1)	Generic Excess Soil Quality Standard (Note 2)	Property Use (Note 3)
*	*	*	*	*

Notes:
1. Depth as measured from the original ground surface.
2. Values refer to the table number in Appendix 1 of Rules for Soil Management and Excess Soil Quality Standards.
3. Values are acronyms coinciding with table headings in Appendix 1 of Rules for Soil Management and Excess Soil Quality Standards.
   AO = Agricultural and Other Property Use,
   RPIICC = Residential/Parkland/Institutional/Industrial/Commercial/Community Property Use,
   RPI = Residential/Parkland/Institutional Property Use,
   ICC = Industrial/Commercial/Community Property Use,
   (Surf) = Surface, and (Sub) = Subsurface.

Designer Fill-Ins for Table 3:

Fill in Table 3 based on information supplied by environmental project team members, or within an environmental or geotechnical report. When the appropriate soil quality standard is uncertain, specify the more restrictive standard.

Example Fill-Ins for Table 3:

Township	Station (Offset)	Excavation Depth Range (Note 1)	Generic Excess Soil Quality Standard (Note 2)	Property Use (Note 3)
Cameron	12+300 – 17+546		Table 1: Ceiling Values for Excess Soil Reuse	AO, RPIICC
Cameron	17+546 – 18+912	0 – 2.5 m	Table 3: Ceiling Values for Full Depth Excess Soil in a Non-Potable Ground Water Condition	RPI
Cameron	17+546 – 18+912	2.5 m – 7 m	Table 2.1: Ceiling Values for Full Depth Excess Soil in a Potable Ground Water Condition	ICC
Cameron	18+912 – 21+640		Table 1: Ceiling Values for Excess Soil Reuse	AO, RPIICC
Jacob	10+000 – 13+460		Table 1: Ceiling Values for Excess Soil Reuse	AO, RPIICC
Jacob	13+460 – 14+125 (2 m Lt – 14 m Rt)		Table 4.1: Ceiling Values for Stratified Excess Soil in a Potable Ground Water Condition	ICC (Sub)
Jacob	13+460 – 14+125 (12 m Lt – 2 m Lt)		Table 1: Ceiling Values for Excess Soil Reuse	AO, RPIICC
Jacob	14+125 – 19+567		Table 1: Ceiling Values for Excess Soil Reuse	AO, RPIICC

Example Fill-Ins for Table 3:

Township	**Station (Offset)**	**Excavation Depth Range** (Note 1)	**Generic Excess Soil Quality Standard** (Note 2)	**Property Use** (Note 3)
Entire Working Area			Table 1: Ceiling Values for Excess Soil Reuse	AO, RPIICC

Related Ontario Provincial Standard Drawings

No information provided here.

GENERAL SPECIFICATION FOR ENVIRONMENTAL PROTECTION FOR CONSTRUCTION IN WATERBODIES AND ON WATERBODY BANKS

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APPENDICES

182-A **Commentary**

182.01 SCOPE

This specification describes requirements that apply to construction involving work in waterbodies and waterbody banks, including temporary watercourse relocations and temporary waterbody crossings.

This specification applies to the work of waterbody and fish habitat protection without limiting the conditions and approvals imposed by statute.

182.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

182.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

182.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 517 Dewatering
OPSS 805 Temporary Erosion and Sediment Control Measures

Ontario Provincial Standard Specifications, Material

OPSS 1004 Aggregates - Miscellaneous
OPSS 1860 Geotextiles

Canadian and Provincial Statutes

Fisheries Act, R.S.C., 1985, c. F-14

182.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Dam means a material or a group of materials that are used to prevent water flow into and out of a work area within a waterbody.

Deleterious Substance means as defined by the Fisheries Act.

Flow Control Device means a material or a group of materials that are used to control water flow into and out of a water conveyance device.

Interface means the area of contact between any temporary and permanent waterbody.

Original Watercourse Channel means the channel in which a watercourse was flowing prior to the commencement of the Work.

Plug means the portion of the original bank separating the original watercourse channel from a water conveyance device.

Temporary Waterbody Crossing means a temporary crossing limited to the conveyance of construction equipment and vehicles and includes a fill and culvert or a bridge.

Temporary Watercourse Channel means the channel in which a watercourse is flowing at the completion of any relocation sequence from another channel.

Temporary Water Passage System means a dam in conjunction with a water conveyance device, that is used to isolate a work area from a waterbody, and includes a temporary watercourse channel, a fill and culvert, or a pumping or piping system or both.

Waterbody means any permanent or intermittent, natural or constructed body of water including lakes, ponds, wetlands and watercourses.

Waterbody Bed means the bottom of the waterbody.

Waterbody Bank means the terrain alongside the bed of the waterbody. The bank consists of the sides of the waterbody within which water is confined.

Water Conveyance Device means a device that is used to move water around or through a work area in a waterbody and includes a flow control device.

Watercourse means a stream, creek, river, or channel including ditches, in which the flow of water is permanent, intermittent, or ephemeral.

182.04 DESIGN AND SUBMISSION REQUIREMENTS

182.04.01 Submission Requirements

Two copies of a written strategy shall be submitted to the Contract Administrator for review and permission to proceed with the work at each location in waterbodies and on waterbody banks as specified in OPSF 182-1. This strategy shall be submitted a minimum of 10 Working Days prior to the commencement of work at each location.

For the work at each location, the strategy shall provide descriptions, Working Drawings, and schedules that fully describe the sequence of the work, the associated waterbody and fish habitat protection, and the related contingency measures associated with each stage of the work. The schedule shall include approximate date of installation, removal, and site restoration.

Such information shall be provided at a level of detail, which addresses materials, equipment, methods employed, and procedures to be followed to provide effective waterbody and fish habitat protection and to comply with statutory authorizations, approvals, and permits. The submission shall also include a schedule of checking and monitoring the work to ensure compliance with the strategy.

The strategy shall apply to:

a) all phases of the work, and transitions between phases of the work.

b) the installation, operation, and removal of waterbody and fish habitat protection measures, and transitions between any adjacent environmental protection including temporary erosion and sediment control measures.

c) the interfaces between waterbodies and temporary water passage systems.

d) the containment or stabilization of disturbed earth material, including and during the winter period and other shutdown periods, to prevent entry of such materials into waterbodies.

The Contract Administrator shall respond within 10 Working Days to each submission or resubmission by either giving permission to proceed, or returning the submission marked "Revise and Resubmit" and giving reasons.

Permission to proceed shall not constitute acceptance of the technical adequacy of the strategy.

Written notification shall be submitted to the Contract Administer two Days prior to the actual date of installing or removing protection measures and initiating or completing other work specified in OPSF 182-1.

182.05 MATERIALS

182.05.01 General

Culvert type, cofferdam and dam material, flow control device, channel lining, and bank protection shall be according to OPSF 182-1.

182.05.02 Cofferdam, Dam and Flow Control Device

A cofferdam, dam, or flow control device shall not contain deleterious substance.

182.05.03 Geotextile

Geotextile shall be according to OPSS 1860.

182.05.04 Rip-Rap, Gabion Stone and 19.0 mm Clear Stone

Rip-rap, gabion stone, and 19.0 mm clear stone shall be according to OPSS 1004.

182.05.05 Rounded Stone

Rounded stone shall be no less than 60 mm and no more than 300 mm in dimension and shall be cobbles, pit run fieldstone, or other natural stone material with rounded edges.

182.05.06 Turbidity Curtain

Turbidity curtain geosynthetic and hardware shall be according to OPSS 805.

182.06 EQUIPMENT

All equipment used for work in waterbodies, on waterbody banks, watercourse relocations, and temporary waterbody crossings shall be free of earth material, and excess, loose or leaking fuel, lubricants, coolant and other contaminates that could enter the waterbody.

182.07 CONSTRUCTION

182.07.01 General Requirements

The work shall be controlled to provide effective waterbody and fish habitat protection. The work shall be monitored, and whenever such protection is found to be ineffective, the Contract Administrator shall be advised, changes to the work shall be made immediately to ensure waterbody and fish habitat protection, and an amendment to the strategy shall be submitted within 10 Days.

Unless specified in the Contract Documents, watercourses shall not be diverted, relocated, or blocked, waterbodies shall not be filled, and temporary waterbody crossings shall neither be constructed nor utilized.

Unless work is specified in waterbodies or on waterbody banks, vehicles and equipment shall not enter or be operated within such areas.

All staff on site shall be briefed about the strategy required in the subsection Submission Requirements, and their role in its implementation.

Temporary water passage system, temporary waterbody crossing, cofferdam, turbidity curtain, and temporary erosion and sediment control measures shall be installed prior to commencing the associated work.

Prior to the removal of low vegetative cover, mitigation techniques for erosion and sediment control shall be in place and remain effective at all times, including during shut down periods.

Vehicular maintenance and refuelling shall be conducted away from waterbodies and waterbody banks. All equipment maintenance and refuelling shall be controlled to prevent any discharge of equipment fuels and fluids onto the ground or into waterbodies.

Excess materials, construction debris, containers, and stockpiles of erodible materials shall be stored to prevent them from entering a waterbody. Such storage areas shall be a minimum of 30 m from a waterbody or temporary watercourses channels.

Water discharge from temporary water passage systems, temporary waterbody crossings, cofferdams, dams, and turbidity curtains shall be controlled so as to prevent entry of deleterious substances into waterbodies, prevent erosion of waterbody bed and banks, and prevent harm to aquatic wildlife.

Discharge of water from dewatering operations shall be according to OPSS 517.

The environmental requirements for blasting in or near waterbodies shall be performed as specified in the Contract Documents.

When working in waterbodies, on waterbody banks, and in temporary watercourse channels:

a) The work area shall be isolated from those portions of the waterbody or waterbody banks wherein work is not specified.

b) The extent of disturbance to waterbody bed and banks shall be kept to the minimum necessary for the construction as specified in the Contract Documents. The limit of the area to be disturbed shall be clearly marked prior to commencement of the work. The markings shall be maintained for the duration of the Contract. Trees, shrubs, and other vegetation shall be preserved when possible.

c) The operation of equipment within such areas, the number of entry and exit points, plus the distance from the entry point to the work area, shall be kept to the minimum necessary to perform the specified work.

d) The work and all subsequent site completion and restoration shall proceed in a continuous fashion so as to minimize its duration.

e) The work shall not commence while flows are in flood stage.

f) The work shall be conducted so as to prevent harm to fish and aquatic wildlife and to allow fish passage. When pumping and piping is utilized, the intake hose shall be equipped with a screen to prevent entry of fish and aquatic wildlife. Fish and aquatic wildlife stranded by the work shall be captured and released without harm to the waterbody, or that portion of the waterbody outside the protection system.

g) Protection measures and work are permitted only at the locations and in compliance with the conditions specified in OPSF 182-1. Timing constraints identified on OPSF 182-1 are in force regardless of the timing of the Contract award. The Owner has obtained the necessary authorizations, approvals, and permits for the conditions specified in OPSF 182-1.

182.07.02 Temporary Water Passage System

182.07.02.01 General

The temporary water passage system shall be constructed and fully functional prior to conducting other work in a waterbody or on waterbody banks.

The water conveyance device shall be free of deleterious substances, construction materials, and equipment prior to its use. No release of deleterious substances or sudden surge of water into or out of the water conveyance device shall occur during the opening process.

When a dam is constructed with earth or rock materials on a soft waterbody bed, the first layer of fill shall be rounded stone. The dam shall form a seal around the culvert end, when the water conveyance device is a culvert placed in the original watercourse.

182.07.02.02 Installation

Installation of a temporary water passage system shall be according to the following sequence:

a) The water conveyance device shall be installed and, when specified in the Contract Documents, channel lining shall be applied. When the water conveyance device is a temporary culvert outside the original watercourse channel or is a temporary watercourse channel, the flow in the original watercourse channel shall remain undisturbed until the water conveyance device is installed. Plugs separating the original watercourse channel and the water conveyance device shall remain in place until the water conveyance device is completed.

b) The water conveyance device shall be opened to water flow. When the water conveyance device is a temporary culvert outside the original watercourse channel, or when it is a temporary watercourse channel, the water conveyance device shall be opened by completely opening or removing the downstream flow control device prior to the upstream flow control device.

c) The upstream dam shall be completely installed prior to the downstream dam. If a cover material is specified in the Contract Documents, it shall be applied to each dam immediately upon placement of each dam.

182.07.02.03 Removal

Removal of a temporary water passage system shall be according to the following sequence:

a) All work in the work area shall be completed.

b) All materials and equipment not specified to remain in the waterbody shall be removed.

c) The downstream dam shall be completely removed prior to the upstream dam. Rounded stone in soft waterbody beds shall remain in place whenever it is below the bed level of the waterbody.

d) The water conveyance device shall be removed. When the water conveyance device is a temporary culvert outside the original watercourses, or is a temporary channel, it shall be closed to flow and removed according to the following sequence:

   i. An upstream flow control device shall be completely installed prior to a downstream flow control device.
   ii. The bank shall be restored and, and when specified in the Contract Documents, bank protection shall be applied immediately upon closure or installation of each flow control device.
   iii. Backfilling and any other work shall be conducted so as to prevent discharge of deleterious substances into the original watercourse.

182.07.03 Temporary Waterbody Crossing

Temporary waterbody crossings shall be constructed at right angles to the waterbody.

When temporary waterbody crossings are constructed with rock materials on soft waterbody beds, a layer of rounded stone shall be placed as a base material. Equipment may enter the waterbody during the crossing construction and removal, provided it is operated on this material bed.

When fill is placed in a waterbody and within 15 m of a waterbody, it shall be rip rap, gabion stone, or larger aggregate that meets the same material requirements.

An even driving surface may be constructed only by using rubber mats or 19 mm clear stone placed over a geotextile separator.

Temporary crossings and their approaches shall be constructed and maintained to prevent entry of deleterious substance to the waterbody.

Wheeled and tracked vehicles shall be prevented from carrying earth materials that have accumulated in the wheels or tracks onto the crossing.

The temporary crossing shall be removed when it is no longer required. All crossing materials shall be removed. Rounded stone in soft waterbody beds shall remain in place when it is below the bed level of the waterbody. Immediately upon removal of the temporary crossing, the bank protection, as specified in the Contract Documents, shall be applied and the site shall be restored.

182.07.04 Cofferdams and Turbidity Curtains

Cofferdams and turbidity curtains shall be according to OPSS 805.

182.07.05 Site Restoration

The waterbody and waterbody banks shall be restored to the finished condition as specified in the Contract Documents.

182.07.06 Contingency Measures

A standby supply of pre-fabricated silt fence barrier or an equivalent ready-to-install sediment control device sufficient to extend a linear distance of 200 m shall be stored at the Contract site at all times, including during shut down periods, for immediate deployment.

A fully operational standby pump of the same capacity as that specified in OPSF 182-1 shall be stored at the work site at all times while pumping and piping is being used for temporary waterbody passage.

182.07.07 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

182.10 BASIS OF PAYMENT

Payment at the Contract price for the appropriate tender items requiring work in waterbodies and on waterbody banks shall be full compensation for the labour, Equipment, and Material for the protection of waterbodies and fish habitat.

PERMITTED WORK IN WATERBODIES, ON WATERBODY BANKS AND ADJACENT TO WATERBODIES

Waterbody and Location	Permitted Protection Measures and Work		Design and Construction Details Including Site Restoration	Timing Constraints (see note)
For each waterbody and location within the Contract limits, specify: 1. waterbody name/location 2. stations and offsets pertinent to the work permitted and the fisheries and protection measures selected.	Temporary Water Passage	Culvert (OPSD 221.010)	Specify # of culverts, culvert dimensions; invert elevations; bedding material; dam material/details; scour protection.	
		Piping and Pumping (OPSD 221.020)	Specify capacity/end points; dam material/details; scour protection.	
		Channel (OPSD 221.030)	Specify end points; channel dimensions; channel lining; flow control device; dam material/details, culvert details as listed below under culvert, if required.	
	Temporary Waterbody Crossing	Fill and Culvert (OPSD 221.040)	Specify # of culverts, culvert dimensions; maximum fill base width; maximum fill elevation; scour protection; waterbody bank protection.	
		Bridge	Specify type of structure; opening dimensions; pier setback; waterbody bank protection.	
	Cofferdam, Dam, Turbidity Curtain		Specify end points; channel dimensions or maximum penetration; maximum dam base width; maximum dam elevation; dam material/details.	
	Isolation of work area from Waterbody and Waterbody Bank.		Specify temporary barricade, identification of area in which any entry is prohibited, etc.	
	Other work in waterbodies and on waterbody banks.		Specify details of permitted work.	

To be completed by the Owner in consultation with regulatory agencies and is to be used in conjunction with OPSS 182 and shall form part of the Contract Documents. A separate form is required for each work area in waterbodies and on waterbody banks.

Note:

For each protection measure and for any other work, specify one or a combination of:

1. Dates between which protection measure installation is permitted and dates between which protection measure removal is permitted.

2. Dates between which protection measure can be in place; or

3. Maximum period (e.g., # of days) that protection measure can be in place.

4. A separate form is required for each work area in waterbodies and on waterbody banks.

OPSF 182-1 (November 2012)

PERMITTED WORK IN WATERBODIES, ON WATERBODY BANKS AND ADJACENT TO WATERBODIES

Waterbody and Location	Permitted Protection Measures and Work		Design and Construction Details Including Site Restoration	Timing Constraints (see note)
	Temporary Water Passage	Culvert (OPSD 221.010)		
		Piping and Pumping (OPSD 221.020)		
		Channel (OPSD 221.030)		
	Temporary Waterbody Crossing	Fill and Culvert (OPSD 221.040)		
		Bridge		
	Cofferdam, Dam, Turbidity Curtain			
	Isolation of work area from Waterbody and Waterbody Bank.			
	Other work in waterbodies and on waterbody banks.			

To be completed by the Owner in consultation with regulatory agencies, and is to be used in conjunction with OPSS 182 and shall form part of the Contract Documents. A separate form is required for each work area in waterbodies and on waterbody banks.

OPSF 182-1 (November 2012)

Appendix 182-A, November 2021
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

OPSS 182 and Ontario Provincial Form (OPSF) 182-1 may be required whenever work is proposed in waterbodies and on waterbody banks.

OPSS 182 and OPSF 182-1 should not be included in the Contract, unless necessary authorizations, approvals, and permits can be obtained from the appropriate regulating agencies.

The Owner should complete OPSF 182-1 with the necessary environmental protection information, in consultation with the appropriate regulatory agencies. The completed OPSF 182-1 is to be included in the Contract Documents.

The completed form should reflect the requirements of any formal approvals, permits or authorizations obtained, or the requirements that avoid the need for such authorization. In some cases, OPSF 182-1 should refer to the actual authorization attached to the Contract. A blank copy of OPSF 182-1 is attached along with an example of information required to complete the form.

It may be necessary to augment the completed OPSF 182-1 with project-specific Contract Drawings.

Use of the OPSDs listed below are subject to the same conditions and approvals as OPSF 182-1.

If a form other than OPSF 182-1 is to be used for submission purposes, the alternate form should be invoked by reference in the Contract Documents and the specification should be amended to remove reference to OPSF 182-1.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Significant Clauses

The requirements of subsection 182.07.01 are intended to avoid unauthorized destruction of fish habitat by the Contractor and thereby minimize the potential for charges being laid against the Owner and Contractor. For this section to be effective, the Owner must ensure that all waterbodies, including seasonally dry fish habitat, within the Contract limits are identified in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 221.010	Temporary Flow Passage System, Culvert in Watercourse
OPSD 221.020	Temporary Flow Passage System, Pumping and Piping
OPSD 221.030	Temporary Flow Passage System, Temporary Channel or Culvert Outside Watercourse
OPSD 221.040	Temporary Waterbody Crossing, Fill and Culvert

Note: The MUNI implemented in April 2019 replaces OPSS 201 COMMON, November 2011 with no technical content changes.

CONSTRUCTION SPECIFICATION FOR CLEARING, CLOSE CUT CLEARING, GRUBBING, AND REMOVAL OF SURFACE AND PILED BOULDERS

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201-A **Commentary**

201.01 SCOPE

This specification covers the requirements for the removal of trees, brush, bushes, stumps, windfalls, surface boulders, and piled boulders.

201.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

201.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

201.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 206 Grading

Ontario Government Publications

Crown Forest Sustainability Act, 1994, S.O. 1994, c. 25

201.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Clearing means the cutting of all standing trees, brush, bushes, and other vegetation to a maximum height of 300 mm above original ground level and the removal of felled materials and windfalls.

Close Cut Clearing means the cutting of all standing trees, stumps, brush, bushes, and other vegetation at original ground level and the removal of felled materials and windfalls.

Grubbing means the removal of all stumps, roots, embedded logs, debris, and secondary growth.

Piled Boulders means any cobbles, boulders, or rock fragments that have been placed in fencerows or piles.

Rock means rock as defined in OPSS 206.

Surface Boulder means any boulder or rock fragment that measures 200 mm or greater in any one dimension, extends a minimum of 200 mm above original ground, and can be removed without excavation.

201.04 DESIGN AND SUBMISSION REQUIREMENTS

201.04.01 Submission Requirements

201.04.01.01 Crown Forest

Crown forest, as defined by the Crown Forest Sustainability Act, shall not be cut until a permit has been obtained from the Ministry of Natural Resources and Forestry (MNRF).

201.07 CONSTRUCTION

201.07.01 General

Trees measuring 150 mm or more in diameter, measured 1.0 m above ground, shall be cut, limbed, and stacked for collection by others. Cut trees shall not be stacked in or transported through areas identified as being environmentally sensitive in the Contract Documents or elsewhere by an Authority.

When specified in the Contract Documents, cut trees shall be stacked outside and adjacent to the right-of-way for the property owner, adjacent to and between the stations listed.

Within Crown Land areas specified in the Contract Documents for clearing and close cut clearing, marketable timber shall be made available for purchase from the Contractor to the holder of the sustainable forest licence. All cut and stacked trees shall be cut into lengths agreed to by the Contractor and the sustainable forest licence holder, but in no case exceeding 5.0 m.

All timber not purchased by others or stacked for adjacent landowners is excess material.

The work shall not damage or disturb the area outside the areas specified in the Contract Documents.

When work is done in or near waterbodies or waterbody banks, the work shall be according to the Contract Documents.

201.07.02 Clearing

The work shall consist of clearing all areas of earth excavation, earth surfaces to be covered by embankments up to and including 1.2 m in height, and any other areas specified in the Contract Documents.

201.07.03 Close Cut Clearing

The work shall consist of close cut clearing all earth surfaces to be covered by embankments greater than 1.2 m in height, and any other areas specified in the Contract Documents.

201.07.04 Grubbing

The work shall consist of grubbing all areas of earth excavation, earth surfaces to be covered by embankments up to and including 1.2 m in height, and any other areas specified in the Contract Documents.

Grubbing is not required in swamps.

Mechanical stump cutters are permitted, provided the entire root structure is removed.

Depressions remaining after grubbing shall be backfilled with suitable earth material and compacted to avoid settlement.

When clearing has been previously completed by others, all secondary growth, brush, and debris shall be removed.

Piled boulders and surface boulders that are not specified in the Contract Documents for removal and lie within areas to be grubbed shall be removed.

201.07.05 Removal of Surface Boulders and Removal of Piled Boulders

The work shall consist of the removal of surface boulders and removal of piled boulders within the areas specified in the Contract Documents.

Depressions remaining after removal shall be backfilled with suitable earth material and compacted to avoid settlement.

201.07.06 Mechanical Stump Cutting

The work shall consist of mechanical cutting of stumps to a depth of 150 mm below original grade, as specified in the Contract Documents.

201.07.07 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

201.09 MEASUREMENT FOR PAYMENT

201.09.01 Actual Measurement

Measurement shall be by area or by each, as specified in the Contract Documents.

201.09.01.01 Clearing, Close Cut Clearing, and Grubbing

Measurement of clearing, close cut clearing, and grubbing shall be by area or by each, as specified in the Contract Documents.

201.09.01.01.01 By Area

Removal shall be measured by area in a horizontal plane in hectares or square metres.

201.09.01.01.02 By Each

For measurement purposes, a count shall be made of the trees or stumps removed.

201.09.01.02 Removal of Surface Boulders and Removal of Piled Boulders

Removal shall be measured by area in a horizontal plane in hectares or square metres.

201.09.01.03 Mechanical Stump Cutting

For measurement purposes, a count shall be made of the stumps removed by mechanical cutting.

201.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

201.10 BASIS OF PAYMENT

201.10.01 Clearing - Item
Close Cut Clearing - Item
Grubbing - Item
Removal of Surface Boulders - Item
Removal of Piled Boulders - Item
Mechanical Stump Cutting - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Areas designated for removal of piled boulders that lie within areas specified in the Contract Documents for either grubbing or removal of surface boulders shall be paid separately with no deduction from the grubbing or surface boulder removal item.

Removal of individual boulders that are 1 m^3 and greater in volume, shall be paid as rock excavation according to OPSS 206.

Appendix 201-A, April 2019
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Areas identified for clearing, close cut clearing, grubbing, removal of surface boulders and removal of piled boulders, and mechanical stump cutting, in addition to those areas required by this specification. (201.07)

- Areas identified as being environmentally sensitive. (201.07.01)

- Areas for clearing and close cut clearing within Crown Land. (201.07.01)

- Areas where cut trees are to be stacked. (201.07.01)

- The areas where work is to be done in or near waterbodies or waterbody banks. (201.07.01)

- Review crown land clearing with Ministry of Natural Resources and Forestry (MNRF) to determine volume of marketable timber available. (201.07.01)

- Identify holders of sustainable forest licences and their addresses from the MNRF and make them available to the Contractor. (201.07.01)

- Method of measurement for clearing, close cut clearing, and grubbing. (201.09.01.01)

When surface boulders and piled boulders are to be removed that are outside the general grading limits, the Removal of Surface Boulders and Removal of Piled Boulders items should be used.

Swamp excavation areas do not require grubbing, therefore, designers should not include a grubbing quantity in the Contract Documents for these areas.

The designer should include an additional quantity for individual boulders over 1 m^3 in the rock excavation quantity. (201.10.01)

Mechanical stump cutting should be considered to avoid damage to adjacent structures that may result from grubbing.

Piled boulders greater than 100 m^3 should be designated for removal and be included for payment in the tender item for Removal of Piled Boulders regardless of where they are located.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

CONSTRUCTION SPECIFICATION FOR ROCK REMOVAL BY MANUAL SCALING, MACHINE SCALING, OR TRIM BLASTING

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202.10 **BASIS OF PAYMENT**

APPENDICES

202-A **Commentary**

202.01 SCOPE

This specification covers the requirements for removing rock by manual scaling, machine scaling, or trim blasting.

202.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

202.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

202.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 201	Clearing, Close Cut Clearing, Grubbing, and Removal of Surface and Piled Boulders
OPSS 206	Grading

202.03 DEFINITIONS

For the purpose of this specification, the definitions in OPSS 201 and OPSS 206 and the following definitions apply:

Rock Cut Sounding means any non-destructive method using mechanical or electronic devices to acoustically determine areas where rock is partially or completely detached from the main rock mass.

Trim Blasting means a blasting technique involving the drilling of a single row of closely-spaced holes along the excavation limits, loading them with light, well-distributed charges, completely stemmed, and simultaneously firing the charges.

202.04 DESIGN AND SUBMISSION REQUIREMENTS

202.04.01 Submission Requirements

A minimum of 5 Business Days prior to beginning the manual scaling work, the following shall be submitted to the Contract Administrator, for information purposes only:

a) Name and contact number of the on-site person that is responsible for the work being carried out (i.e., foreperson), and a written statement showing that they have had at least 5 years of related work experience, including dates, and has taken all appropriate safety training.

b) Proof of training certification for all staff performing the manual scaling work.

c) A safety plan which may include the assignment of additional equipment and personnel or the use of special work methods and procedures, including site-specific communication and rescue procedures, to ensure that in the event of an incident, the recovery of an injured worker suspended at height or any other member of the work unit can be undertaken in a timely manner.

A copy of the safety plan shall be kept on site both prior to and during the manual scaling work.

202.06 EQUIPMENT

202.06.01 Lifting Equipment

Lifting equipment shall consist of a two-person aerial lift, crane, or other equipment suitable to access the work.

202.06.02 Drilling Equipment

Drilling equipment shall consist of a hydraulic track drill or other suitable drilling equipment acceptable to the Contract Administrator and capable of producing holes accurately and uniformly across the top of a rock cut to the depth as specified in the Contract Documents.

202.06.03 Excavator

Excavators shall have a minimum operating weight of 30,000 kg and shall be capable of operating to a minimum height of 10 m.

202.06.04 Hoe-Ram Excavator

An excavator shall be equipped with a minimum 5,200 J hydraulic impact hammer.

202.07 CONSTRUCTION

202.07.01 General

The removal of rock by scaling or blasting or both shall include the following:

1. All equipment, including any lifting equipment, materials, and labour that is:

    a) necessary to gain access to the rock removal locations as specified in the Contract Documents.

    b) required by the Owner to obtain access to any areas where:

i. the work is being inspected;
ii. quantities are to be measured; or
iii. quality assurance and acceptance procedures are being conducted.

2. All associated mucking, hauling, and management of rock material.

Removal of rock shall always be carried out in such a manner as to minimize fracturing and all other disturbance to the surrounding rock beyond the removal limits as specified in the Contract Documents.

All blasting, including the use of explosives, shall be as specified in the Contract Documents.

202.07.02 Scaling

202.07.02.01 General

Scaling shall consist of the complete removal of all loose and partially-detached rock at the locations and heights as specified in the Contract Documents.

Scaling shall begin at the top of the rock cut and progress to lower elevations as the work proceeds. As the scaling progresses, care shall be taken to avoid undercutting the upper sections of the scaled rock cut.

The scaling crew shall be in continuous full-time radio contact with the foreperson to permit direct and immediate control.

Each Day, the scaling crew shall inspect the rock cut:

a) prior to the start of work and remove any identified loose or visually unstable rock that may endanger workers.

b) prior to shutdown and remove any identified loose or visually unstable rock that may endanger the traveling public.

202.07.02.02 Manual Scaling

Manual scaling shall consist of the complete removal of all loose and partially-detached rock at the locations and heights as specified in the Contract Documents by the manual scaling work unit and shall also include the following:

a) Rock cut sounding.

b) Scaling of the rock cut with hand tools and hand-held machine tools.

c) Grubbing as required to complete the manual scaling.

Manual scaling may include blasting with small quantities of explosives when specified in the Contract Documents.

As a minimum, the manual scaling work unit shall consist of the following:

a) Two labourers that are experienced in doing scaling work at the heights required in the Contract.

b) All tools and materials required for the performance of the work.

202.07.02.03 Machine Scaling

Machine scaling shall consist of the complete removal of all loose rock and partially-detached rock at the locations and heights as specified in the Contract Documents and shall also include the following:

a) Rock cut sounding.

b) Scaling of the rock cut.

c) Grubbing as required to complete the machine scaling.

As a minimum, the machine scaling work unit shall consist of the following:

a) Either a:

   i) Backhoe excavator equipped with a narrow scaling/ditching bucket and hydraulic thumbs; or
   ii) Hoe-ram excavator.

b) All tools and materials required for the performance of the work.

202.07.03 Trim Blasting

202.07.03.01 General

Trim blasting shall consist of drilling and blasting to remove the rock as specified in the Contract Documents, while minimizing damage to the surrounding rock.

Any loosened or partially-detached rock shall be properly scaled as specified in the Scaling subsection.

202.07.03.02 Trim Blasting

Trim blasting shall include locating and drilling a minimum 50 mm diameter vertical or battered holes along the perimeter of the specified trim at a maximum spacing of 750 mm or at a spacing approved by the Contract Administrator.

202.07.04 Management of Excess Material

When possible, excess rock material shall be managed within the right-of-way by slope flattening at locations approved by the Contract Administrator or as specified in the Contract Documents.

202.09 MEASUREMENT FOR PAYMENT

202.09.01 Actual Measurement

202.09.01.01 Rock Excavation, Manual Scaling

Measurement of rock excavation by manual scaling shall be by time in hours that the scaling crew is actively and necessarily engaged on the work.

202.09.01.02 Rock Excavation, Machine Scaling

Measurement of rock excavation by machine scaling shall be the cumulative sum of the time in hours that each individual scaling unit is actively and necessarily engaged on the work.

202.09.01.03 Rock Excavation, Trim Blasting

Measurement of rock excavation by trim blasting shall be by length in metres of drilling required or volume in cubic metres as specified in the Contract Documents.

202.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

202.10 BASIS OF PAYMENT

202.10.01 Rock Excavation, Manual Scaling - Item
Rock Excavation, Machine Scaling - Item
Rock Excavation, Trim Blasting - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

202.10.02 Disposal, Earth and Rock

Payment for the disposal of earth and rock materials generated from manual scaling and machine scaling shall be according to OPSS 206.

Appendix 202-A, November 2022
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Depth of rock removal. (202.06.02)

- Locations necessary to gain access to the rock removal. (202.07.01)

- Removal limits. (202.07.01)

- All blasting, including the use of explosives. (202.07.01)

- Locations and height of removal of scaling. (202.07.02.01)

- Where and when small quantities of explosives are required with manual scaling. (202.07.02.02)

- Rock that shall be removed by trim blasting. (202.07.03.01)

- Whether excess rock material is to be managed within the right-of-way by slope flattening or other locations. (202.07.04)

- Whether payment for rock excavation by trim blasting shall be by length in metres of drilling required or by volume in cubic metres. (202.09.01.03)

If rock excavation is required for reasons other than manual scaling, machine scaling, or trim blasting, the Designer should include a separate item under Rock Excavation according to OPSS.MUNI 206.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

CONSTRUCTION SPECIFICATION FOR ROCK STABILIZATION

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203-A **Commentary**

203.01 SCOPE

This specification covers the requirements for the stabilization of a rock face or mass using a combination of rock bolts, shotcrete or concrete buttresses or both.

203.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

203.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

203.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 904	Concrete Structures
OPSS 905	Steel Reinforcement for Concrete
OPSS 931	Structure Rehabilitation - Shotcrete

Ontario Provincial Standard Specifications, Material

OPSS 1440	Steel Reinforcement for Concrete

ASTM International

A 123-17	Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
A 820-90	Standard Specification for Steel Fibers for Fiber-Reinforced Concrete
C 33-18	Standard Specification for Concrete Aggregates
C 42-18a	Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
C 150-19a	Standard Specification for Portland Cement
D 1784-11	Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds

Others

ACI 506.2-77 Specification for Materials, Proportioning and Application of Shotcrete ISRM (International Society for Rock Mechanics) Suggested Method for Rock Anchorage Testing

203.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Basal Plane means a planar discontinuity within a rock mass along which one portion of the mass could slide over another.

Nozzle Operator means as defined in OPSS 931.

Rock Bolting means the pinning of a rock block or rock mass in-situ using grouted steel bars.

203.04 DESIGN AND SUBMISSION REQUIREMENTS

203.04.01 Submission Requirements

203.04.01.01 Rock Bolting

The following information shall be submitted to the Contract Administrator for information purposes a minimum of two weeks prior to starting the work:

a) The name and statement of experience of the persons or firm responsible for installing the rock bolts.

b) The name of the firm supplying the rock bolts.

c) The name of the firm supplying the resin cartridge.

d) The type, set time and dimensions of the resin cartridge, the drill hole diameter, and the installation methodology to be used.

e) The mill certificates for the rock bolts to be used.

f) The type of grout, the drill hole diameter, and installation methodology for grouted rock bolts.

203.04.01.02 Shotcreting

A list of equipment and accessories to be used including the information below shall be submitted for information purposes to the Contract Administrator a minimum of two weeks prior to the application of shotcrete:

a) Equipment type and capacity.

b) Nozzle type and size.

c) Continuous feed predampener details.

d) List of additives to be used along with the name of the supplier.

203.05 MATERIALS

203.05.01 Rock Bolts

Rock bolts shall be a minimum 25M reinforcing steel bars according to OPSS 1440 with a minimum yield strength of 400 MPa and a minimum length of 3.0 m, unless specified elsewhere in the Contract Documents. Rock bolts shall be fully threaded bars or bars threaded at one end and provided with a faceplate of at least 100 x 100 mm in area with a nut and beveled or spherical washers as recommended by the manufacturer. All rock bolt components shall be hot-dip galvanized according to ASTM A123.

203.05.01.01 Anchoring Agent for Rock Bolts

The anchoring agent for rock bolts shall be supplied in cartridges containing a polyester resin with a catalyst that has a maximum nominal gel time of 15 minutes. Fully cured anchoring agent shall have a minimum compressive strength of 50 MPa and a minimum tensile strength of 15 MPa. Resin with an expired shelf life shall not be used.

203.05.01.02 Grout

The grout cube for high early strength grout shall be at least 20 MPa at seven Days and 30 MPa at 28 Days. The type of cement used shall be suitable for the required use of the grout. Accelerators shall not be used. The grout shall bleed less than 2% when allowed to stand for one hour.

203.05.01.03 Grout Tubes

Grout tubes shall have an adequate inside diameter to enable the grout to be pumped to the bottom of the drill hole. They shall be able to withstand a pressure of 1 MPa.

203.05.02 Rock Shotcrete

Shotcrete for rock face stabilization shall consist of the following:

a) Normal Portland cement: 18% - 21% by weight of dry components according to ASTM C150.

b) Silica fume: 10% - 15% by weight of Portland cement containing a minimum of 90% SiO_2 and having a proven record of performance when used in shotcrete.

c) Aggregate: Gradation No.2 in ACI 506.2 having a well-graded distribution with maximum size of 10 mm and according to ASTM C33.

d) Steel Fibre Reinforcement: Quantity as recommended by the supplier and quality according to ASTM 820 or Owner-approved equivalent.

e) Water: Clean and free of substances which may be harmful or corrosive to concrete or steel; the ratio of water to total cementitious material shall be in the range of 0.35 to 0.45:1 and in sufficient quantity to provide good placement characteristics.

f) Additives as required to achieve optimum strength and placement characteristics.

g) Hardened shotcrete at seven Days shall have a minimum compressive strength of 30 MPa.

203.05.02.01 Pipe for Rock Drains

Rock drains shall consist of slotted polyvinyl chloride (PVC) pipe according to ASTM D1784 and have a minimum internal diameter of 19 to 25 mm, inclusive.

203.06 EQUIPMENT

203.06.01 Shotcreting

203.06.01.01 Compressor - Air Blasting

The compressor for air blasting shall have a minimum capacity of 14.2 m^3/min or 500 cfm. The compressed air shall be free from oil and other contaminants.

203.06.01.02 Hand Finishing Equipment

Where hand finishing is required, only magnesium, wood, or sponge rubber floats shall be used.

203.06.01.03 Mixing Process

The dry mix process shall be used.

A continuous feed predampener capable of bringing the dry bagged material to a consistent and suitable moisture content shall be operated at sufficient capacity to allow the work to proceed without delays.

The delivery equipment shall be capable of discharging the mixture into the delivery hose at a rate sufficient to ensure a continuous smooth stream of uniformly mixed shotcrete mixture being delivered to the nozzle at the required velocity.

The discharge nozzle shall be equipped with a manually operated water injection system, for directing an even distribution of liquid through the mixture. The liquid valve shall be capable of ready adjustment to vary the quantity of liquid and shall be convenient for the nozzle operator. The nozzle shall be capable of delivering a conical discharge stream with uniform appearance throughout. The liquid pressure at the discharge nozzle shall be sufficiently greater than the operating air pressure to ensure that the liquid is thoroughly mixed with the other materials. The liquid pressure shall be uniform.

203.07 CONSTRUCTION

203.07.01 Rock Bolting

Holes for rock bolts shall be drilled at the diameter recommended by the resin supplier for the sizes of the rock bolts and cartridges at the locations as specified in the Contract Documents. For grouted rock bolts, holes shall be drilled as specified in the Contract Documents.

Holes shall be drilled in a direction angled downward in order to connect the basal planes and to a depth such that when the rock bolt is fully inserted it protrudes 70 + 20 mm from the rock or shotcrete surface.

The drill holes shall be thoroughly cleaned with compressed air prior to the installation of a polyester resin anchoring agent or grout. The holes shall be filled with anchoring agent or grout to ensure complete encapsulation of the rock bolt and an adequate bond length along the full length of the drill hole while allowing some overflow.

Centralizers shall be maintained in position during installation.

Rock bolts shall be installed according to the resin supplier's installation instructions or as specified in the Contract Drawings. For the resin anchor, during the insertion of the rock bolt in the hole, the bolt shall be steadily rotated by means of a pneumatic tool and suitable coupling attached to the threaded end of the bolt according to the resin manufacturer recommendations. The rotation shall be continued after the bolt has been inserted for a further 15 seconds or according to the recommendations of the resin manufacturer and the bolt shall then be maintained in position until the resin has hardened.

After the rock bolts are fully inserted into the drill holes in a vertical or inclined rock face, the bolts shall be maintained in position to prevent any further loss of resin while the anchoring agent is setting.

Grout shall be pumped or poured through the grout tube until the hole is filled.

The face plate, washer and nut shall be pneumatically fastened to the rock bolts at angles of less than 30 degrees from the perpendicular in order to provide full contact of the faceplate with the rock or shotcrete bearing surface and nominal tensioning of the bolt.

Rock bolts in holes that are not completely filled with anchoring agent or which protrude from the hole by an amount greater or less than the length specified shall not be accepted and shall be replaced at a location as close to the original bolt as possible at no additional cost to the Owner.

Corrosion protection shall be applied to all exposed surfaces not already protected.

203.07.01.01 Testing of Rock Bolts

Rock bolt tests shall be conducted as specified in the Contract Documents to demonstrate the performance of the rock bolts by axial pull tests using a calibrated hollow hydraulic jack.

The rock bolt pull testing shall be carried out according to the International Society for Rock Mechanics (ISRM) standard methods for proof tests in the presence of the Contract Administrator. The axial tensioning equipment shall consist of a hollow plunger type hydraulic jack with a minimum capacity of 200 kN, a hydraulic pump, pressure gauges, displacement gauges capable of measuring displacements of 0.0025 cm, and all necessary accessory items for carrying out rock bolt performance tests. Rock bolts that fail to meet the test criteria shall be reinstalled and tested at no additional cost to the Owner.

203.07.02 Rock Shotcreting

203.07.02.01 Operational Constraints

The Contract Administrator shall be notified of the intent to apply shotcrete a minimum of three Business Days prior to the commencement of the shotcreting operation.

The application of shotcrete shall not proceed until the rock surface has been properly prepared according to this specification and verified by the Contract Administrator.

Shotcreting shall not be carried out when the air temperature or the existing rock surface temperature is below 10 °C, or is likely to fall below 10 °C, or is above 30 °C, or likely to rise above 30 °C throughout the duration of the shotcreting operation, unless protection is provided according to the Contractor's submitted plan.

Shotcreting operations shall be suspended during weather conditions that may adversely affect the quality of the work.

203.07.02.02 Approval of Nozzle Operator

Shotcreting shall be carried out by a nozzle operator who has been certified by participation in the MTO Shotcrete Nozzleman Certification Program and who is on the list of approved nozzle operators for the current construction season.

203.07.02.03 Placing

To ensure that a full bond is developed with the shotcrete, all rock surfaces against which shotcrete is to be placed shall be clean, solid and free from loose or unsound fragments, vegetation or other organic materials, and any foreign substances or other debris.

Immediately prior to wetting the rock surface, all dust and loose material shall be removed using compressed air.

The area to be shotcreted shall be maintained in a wet condition for a period of two hours prior to the application of the shotcrete. Prior to the shotcreting operation, excess water shall be removed from the rock surface using compressed air.

All necessary measures shall be taken during shotcrete application to guard against damage, including damage to passing vehicles which may be caused by excessive rebounding of shotcrete material.

Shotcrete shall be placed to create a minimum 75 mm thick and an average 100 mm thick layer to stabilize fractured rock and support rock overhangs at the locations as specified in the Contract Documents.

During the application of the shotcrete, a steady continuous flow of shotcrete shall be maintained. Any pre-dampened mixture that is not used within one half hour shall not be incorporated into the work.

Shotcrete shall be applied so that there is no sagging or separation of the material in place. All rebound material shall be removed from the work area as the work proceeds. Rebound or waste material shall not be worked back into construction or salvaged and re-used.

The total required depth of shotcrete shall be placed within the same Day.

Immediately after placing shotcrete, the shotcrete surface shall be coated with a curing compound according to OPSS 904.

203.07.02.04 Testing of Rock Shotcrete

Testing of shotcrete shall be according to ASTM C42. If necessary, thicknesses shall be confirmed by core drilling. The minimum number of cores taken will be 1 for every 50 square metres of shotcrete placed at locations selected by the Contract Administrator.

A minimum of five test panels shall be constructed during the work as directed by the Contract Administrator. Specimens from the panels may be tested by the Contract Administrator to determine compliance with this specification.

When the shotcrete has gained sufficient strength and within 36 hours after its placement, all designated in-place shotcrete in both the initial and subsequent shotcreted layers shall be tested in the presence of the Contract Administrator. The testing shall consist of hammering at 300 mm centres to detect any hollow sounding areas.

Areas of shotcrete that are determined by the Contract Administrator to be inadequately bonded or cracked or any area of shotcrete where porous, rebound material, cracks, or sagging are present in cores that are taken within those areas shall be removed and replaced until adequate shotcrete quality and bonding has been achieved. Rehabilitation by other methods shall only be undertaken with the written approval of the Contract Administrator.

203.07.03 Rock Drains

When drain holes are specified in the Contract Documents, the holes shall be drilled to depths of 3.0 m at an inclination of approximately 10 degrees above the horizontal and throughout the shotcrete layer at 2.0 to 3.0 m centres.

The drain holes shall then be lined with tightly-fitting PVC pipe that protrudes approximately 25 to 75 mm outside of the shotcreted face.

203.07.04 Concrete Buttress

Rock cavities shall be filled with reinforced concrete at locations as specified in the Contract Documents.

All work shall be according to OPSS 904.

Concrete shall be 30 MPa at 28 Days.

Dowels into the rock shall be installed into the existing rock base on a grid pattern and to depths as specified in the Contract Drawings.

Reinforcing steel shall be according to OPSS 905.

The resultant concrete face shall be a smooth surface.

203.07.05 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

203.09 MEASUREMENT FOR PAYMENT

203.09.01 Actual Measurement

203.09.01.01 Rock Bolting

For measurement purposes, a count shall be made of the number of rock bolts installed.

203.09.01.02 Rock Shotcrete

Measurement shall be by area in square metres of shotcrete and shall only include those areas that have an average thickness of 100 mm and a minimum thickness of 75 mm.

203.09.01.03 Rock Drains

For measurement purposes, a count shall be made of the number of rock drains installed.

203.09.01.04 Concrete Buttress

Measurement shall be by volume in cubic metres of the reinforced concrete placed.

203.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

203.10 BASIS OF PAYMENT

203.10.01 Rock Drains - Items
Concrete Buttress - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

203.10.02 Rock Shotcreting - Item
Rock Bolting - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Replacement of unacceptable rock bolts and rock shotcreting shall be carried out at no additional cost to the Owner.

Appendix 203-A, November 2019
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer shall specify the following in the Contract Documents:

- Size and properties of the bolts if different from the bolts specified. (203.05.01)

- Grout material to fill annular space between drilled hole and rock bolt. (203.05.01.02)

- Properties of concrete. (203.05.02)

- Spacing and inclination of rock bolts. (203.07.01)

- Dimensions of the holes to be drilled for grouted rock bolts. (203.07.01)

- Testing requirements including acceptance criteria. (203.07.01.01)

- The size, properties, and installation pattern and depths of dowels and reinforcing steel. (203.07.04)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

CONSTRUCTION SPECIFICATION FOR GRADING

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206-A **Commentary**

206.01 SCOPE

This specification covers the requirements for grading, including earth and rock excavation and embankment construction, rock face, and the management of excavated materials.

206.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

206.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

206.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 201	Clearing, Close Cut Clearing, Grubbing, and Removal of Surface and Piled Boulders
OPSS 209	Embankments Over Swamps and Compressible Soils
OPSS 212	Borrow
OPSS 501	Compacting
OPSS 802	Topsoil
OPSS 804	Seed and Cover

Ontario Provincial Standard Specifications, Materials

OPSS 1001	Aggregates - General
OPSS 1010	Aggregates - Base, Subbase, Select Subgrade and Backfill Material

Ontario Ministry of Transportation Publications

MTO Laboratory Testing Manual:

LS-706	Moisture-Density Relationship of Soils Using 2.5 kg Rammer and 305 mm Drop

206.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Angle of Repose means the maximum angle measured from the horizontal at which fill remains stable.

Backslope means the slope in a cut between the invert of the roadside ditch and the point where the slope intersects original ground.

Benching means the keying into existing slopes by excavating horizontal planes. Benching also means the stepping of cut slopes at intermediate levels in deep cuts.

Berm(s) means an extension of an embankment constructed to a lower height and designed to provide road embankment stability.

Bulking Factor means the ratio of the volume of rock material following excavation, placement, and compacting to the original in situ volume of the same material. The bulking factor for rock shall be 1.35.

Cushion Blasting means the placing of a single row of lightly-loaded closely-spaced holes along the excavation limits as specified in the Contract Documents and firing them coincident with the main excavation blast as the last delay sequence to remove rock inside the cut limits.

Ditching means the excavation in earth or rock for all water courses. The term shall include roadside ditches, all excavation lying beyond the end of drainage structures, and stream and watercourse diversions and corrections.

Earth means all soils, except those defined as rock, and excludes stone masonry, concrete, and other manufactured materials.

Embankment means the material placed within the sideslopes; below the top of subgrade; and above the original ground, excavated base, or theoretical bottom, as applicable, to the limits as specified in the Contract Documents. Widening, flattening, or other placement of material adjacent to or on top of sideslopes beyond that specified in the Contract Documents is excluded.

Existing Rock Surface means either the rock surface that is exposed at ground level prior to the beginning of the Contract or the rock surface that is exposed after the overburden above it has been removed during the Contract.

Frontslope means the slope in a cut section between the edge of shoulder and the invert of the roadside ditch.

Grubbing means grubbing as defined in OPSS 201.

Line Drilling means the placing of a single row of very closely-spaced holes without explosives along the rock excavation limits as specified in the Contract Documents.

Mucking means the picking up of broken rock prior to haulage.

Overbreak means any broken, displaced, or loosened rock that originates outside the designated rock excavation limits as specified in the Contract Documents, regardless of whether that rock has been excavated, displaced, or loosened due to the inherent character of the rock formation itself or due to any other cause.

Pre-Shearing means the placing of a single row of closely-spaced lightly-loaded holes along the rock excavation limits as specified in the Contract Documents that are fired simultaneously before and independently of the main excavation blast. Pre-shearing is sometimes referred to as pre-splitting.

Reclaimed Asphalt Pavement (RAP) means RAP as defined in OPSS 1001.

Reclaimed Concrete Material (RCM) means RCM as defined in OPSS 1001.

Roadside Ditch means a ditch with one of its slopes coincident with the road frontslope.

Rock means natural beds or massive fragments of the hard, stable, cemented part of the earth's crust, either igneous, metamorphic, or sedimentary in origin that may or may not be weathered and includes boulders having a volume of 1 m^3 or greater.

Rock Face means the uniform, relatively planar, maintenance-free, vertical or near vertical rock surface between the top of the existing rock surface and the designated rock or ditch grade line that is generally characterized by noticeable drill hole traces and a minimum of blast-induced fractures beyond the rock excavation limits.

Rock Surplus means the rock excavation original tender quantity multiplied by the bulking factor, plus the volume of rock material excavated from all other items as specified in the Contract Documents, minus the rock embankment original tender quantity, minus shatter. Rock overbreak and rock materials resulting from scaling are specifically excluded.

Scaling means the removal of loose, broken, or overhanging rock fragments from an existing rock surface or the removal of loose, broken, or overhanging rock fragments from a rock face that remain in place after the rock has been blasted and mucked.

Shale means a fine-grained, low strength, sedimentary rock that undergoes rapid deterioration on exposure.

Shatter means fractured rock broken by the use of explosives or mechanical means and left in place.

Sideslope means the slope in a fill between the edge of shoulder and the point where the slope intersects original ground.

Spall means a rock fragment, chip, or splinter from a rock surface created by weathering, stress relief, blasting, or a combination thereof.

Stripping means the excavation of the upper layer of soil, that is predominantly organic, too soft, or wet and otherwise unsuitable for the construction of embankments that is done prior to and usually independent of earth excavation or the placement of fill materials or both.

Tolerance means a construction working tolerance only, that is considered to be:

a) Minus when it is:

   i. narrower than the Contract standard when pertaining to horizontal dimensions as measured from centreline, or
   ii. lower in elevation than the Contract standard when pertaining to vertical dimensions.

b) Plus when it is:

   i. wider than the Contract standard when pertaining to horizontal dimensions as measured from centreline, or
   ii. higher in elevation than the Contract standard when pertaining to vertical dimensions.

Wall Control Blasting means a blasting method using carefully spaced and aligned drill holes intended to produce a relatively flat, maintenance-free, rock surface or rock face as specified in the Contract Documents. Wall control blasting techniques are cushion blasting, line drilling, and pre-shearing.

206.04 DESIGN AND SUBMISSION REQUIREMENTS

206.04.01 Submission Requirements

206.04.01.01 Rock Material Management Plan (RMMP)

When a RMMP is specified in the Contract Documents, for each construction stage, the following information shall be submitted to the Contract Administrator a minimum of 5 Business Days prior to commencement of the work for rock excavation or rock embankment:

a) A plan for rock excavation corresponding to the station intervals as specified in the Contract Documents. The plan shall identify the volume in cubic metres of the following:

   i. In-situ rock prior to blasting with shatter quantity shown separately.
   ii. Excavated rock available calculated by applying the bulking factor to the quantity of in-situ rock prior to blasting, less the quantity of shatter.
   iii. Excavated rock to be placed in rock embankment.
   iv. Excavated rock within the Contract limits to be processed into granular material or other aggregates required in the Contract Documents.
   v. Excavated rock to be used for other purposes in completing the Work, such as rock protection, rip rap, or river stone and descriptions and locations of that Work.
   vi. Excavated rock not incorporated into the Work and the locations and uses of that material.

b) A plan for the construction of rock embankments that identifies each location and volume in cubic metres where the material is going to be supplied to the corresponding station intervals as specified in the Contract Documents.

c) The locations and volume in cubic metres where rock materials are to be obtained.

d) The location and volume in cubic metres for each source when additional rock or granular material or both are required to complete the Work.

e) The amount of rock surplus, if any, during the applicable construction stage.

The Contractor shall be solely responsible for the assumptions and the reasonableness of the RMMP.

In addition, an updated RMMP shall be submitted to the Contract Administrator, on a monthly basis, which shall include an ongoing tabulation of all rock materials that have been removed by the Contractor from the rock excavation or not incorporated in embankments, shown as a cumulative reduction in rock surplus.

206.04.01.02 Trial Section for Modified Layer Compaction Method

If the Contractor requests to use the modified layer compaction method, as specified in the Modified Layer Compaction Method clause, a detailed plan shall then be submitted in writing to the Contract Administrator a minimum of 48 hours prior to commencing any work on the required trial section. The plan shall include full details of the placing of material and its compaction, including layer thickness; number and type of compaction units and number of passes.

206.06 EQUIPMENT

206.06.01 Tractor Bulldozer - Crawler Type for Rock Embankment Construction

Tractor bulldozer, crawler type for rock embankment construction as specified in the Rock Embankments, General clause shall have a minimum net flywheel power of 200 kW.

206.06.02 Rollers for Shale Embankment Construction

Pad foot drum roller required for the construction of shale embankments shall weigh a minimum of 18 tonnes and vibratory steel drum or pneumatic-tired rollers shall weigh a minimum of 9 tonnes.

206.06.03 Nuclear Moisture and Density Gauge

Nuclear moisture and density gauges shall meet the requirements of the Nuclear Moisture and Density Gauge subsection of OPSS 501.

206.06.04 Hydraulic Excavator - Crawler Mounted for Rock Embankment Construction

Hydraulic excavator, crawler mounted for rock embankment construction as specified in the Rock Embankments, General clause shall have a minimum operating weight of 32,000 kg.

206.07 CONSTRUCTION

206.07.01 General

206.07.01.01 Removal of Ice, Snow, and Frozen Ground

The Contractor shall remove and dispose of all ice, snow, and frozen material from all earth, rock, or granular surfaces prior to placing fill and from all earth, rock, or granular materials being used for backfill, embankments, or any other construction purposes.

206.07.01.02 Compaction

Earth and granular materials shall be compacted according to OPSS 501.

For compaction purposes, reclaimed asphalt pavement (RAP) or reclaimed concrete material (RCM) or both shall be treated as earth or rock respectively when such material is included in an earth embankment or a rock embankment.

206.07.01.03 Earth Borrow

When earth borrow is specified in the Contract Documents, it shall be according to OPSS 212.

206.07.01.04 Tolerances - General

In the event of a conflict between meeting horizontal grading tolerances and meeting vertical grading tolerances, the vertical grading tolerances shall take precedence.

206.07.01.04.01 Tolerances for Earth

Upon completion, all earth grade surfaces, excluding swamp excavations, shall be shaped to the grades and cross-sections as specified in the Contract Documents within the following tolerances:

a) Vertical grading tolerances for the finished earth subgrade within the limit of the roadway:

+ 30 mm
- 30 mm

b) Horizontal grading tolerances for the vertical faces of excavations to be backfilled:

+ 100 mm
- 0 mm

c) Horizontal grading tolerances for ditch slopes, excluding roadside ditches:

+ 300 mm
- 0 mm

Sideslopes beyond the plus tolerance may be accepted by the Contract Administrator when they are not detrimental to the work.

d) Vertical grading tolerances for all ditching in earth:

+ 30 mm
- 30 mm

e) Horizontal grading tolerances for the backslopes in earth cut sections:

+ 300 mm
- 300 mm

Backslopes beyond the plus tolerance may be accepted by the Contract Administrator when they are not detrimental to the work.

f) Horizontal grading tolerances for each sideslope in earth embankment construction:

+ 300 mm
- 0 mm

g) Horizontal grading tolerances for roadside ditch frontslopes in earth cut sections:

+ 30 mm
- 0 mm

Irrespective of compliance with the above tolerances, the completed slopes shall present a uniform appearance.

206.07.01.04.02 Tolerances for Rock

Completed rock grade surfaces shall be shaped to the grades and cross-sections as specified in the Contract Documents within the following tolerances:

a) Vertical grading tolerances for the finished rock subgrade within the limits of the roadway:

For cut sections:

+ 30 mm
- 100 mm

For fill sections:

+ 30 mm
- 75 mm

Excavation below the minus tolerances may be accepted by the Contract Administrator when it is not detrimental to the work and is brought up to grade as specified in the Rock Excavation, Grading clause.

b) Horizontal grading tolerances for vertical rock face cut limits:

+ 0 mm
- 300 mm

Final faces beyond the plus tolerance may be accepted by the Contract Administrator when they are not detrimental to the work.

c) Horizontal grading tolerances for sloped rock face cut limits:

+ 300 mm
- 300 mm

d) Horizontal grading tolerances for ditch slopes, excluding roadside ditches:

+ 300 mm
- 0 mm

Excavation beyond the plus tolerance may be accepted by the Contract Administrator when the Owner deems it is not detrimental to the work or contribute to additional rock surplus.

e) Vertical grading tolerances for all ditching in rock cuts:

+ 30 mm
- 30 mm

Excavation below the minus tolerance may be accepted by the Contract Administrator when it is not detrimental to the work.

f) Horizontal grading tolerances at the top of each sideslope of rock embankment construction:

+ 300 mm
- 0 mm

206.07.02 Drainage

Excavation operations shall be performed in a manner to avoid water saturation of embankment material and roadway foundation material and to avoid leaving undrained pockets in excavations by providing effective drainage during all stages of the work.

In excavations below subgrade and in stripping operations when provision for surface drainage is impractical, backfill materials shall be placed as soon as possible following the excavation work.

Ditching required to provide for drainage of an embankment shall be completed in advance of the embankment construction. Ditches in roadway cuts shall be constructed as soon as possible to provide drainage from the cuts. Ditches located above and beyond roadway cuts shall be constructed prior to excavating adjacent cuts. When pipe subdrains are required in the bases of roadway cuts, such work shall be carried out at the time that the roadside ditches are being constructed.

206.07.03 Excavation and Grading

206.07.03.01 Earth Excavation - Grading

206.07.03.01.01 General

The work shall include excavating, hauling, handling and placing, shaping, compacting, trimming of earth material, applying temporary cover, and the management of excavated and excess materials as specified in the Contract Documents.

The work shall also include the excavation and removal of pipes and culverts smaller than 200 mm in diameter and expanded polystyrene insulation when located within the limits of the earth excavation, grading work.

Suitable and non-excess earth material excavated from roadway cuts, ditching, and other associated sites shall be used in earth grading and embankment construction, unless otherwise specified in the Contract Documents.

206.07.03.01.02 Stripping

Except when swamp treatment is required, the original ground shall be stripped at the locations and to the depths specified elsewhere in the Contract Documents.

Material required for topsoil re-use shall be stockpiled according to OPSS 802 and as specified in the Contract Documents. Other material obtained from stripping shall be managed as specified in the Management of Excavated Materials clause.

206.07.03.01.03 Excavation Below Subgrade

Unsuitable materials, other than material excavated from swamps, shall be removed below the subgrade to the lengths, widths, and depths as specified in the Contract Documents. The resulting excavation shall be backfilled with material acceptable to the Contract Administrator and compacted according to OPSS 501.

206.07.03.01.04 Swamp Excavation

Swamp excavation shall be according to OPSS 209.

206.07.03.01.05 Backfilling of Overexcavated Areas

When overexcavation occurs, the overexcavated area shall be backfilled with granular material according to OPSS 1010 and compacted according to OPSS 501 at no additional cost the Owner. With the exception of frontslopes and when boulders are encountered in the excavated slopes, backfilling shall not be permitted to obtain the required slopes for excavations.

When boulders are encountered in the excavated slopes, the boulders shall be removed at the direction of the Contract Administrator and the resulting cavity or cavities shall be backfilled with granular material according to OPSS 1010 and compacted according to OPSS 501.

206.07.03.02 Rock Excavation - General

Except where shatter is required, drilling shall not be performed outside of or extend beyond the design excavation limits as specified in the Contract Documents.

The use of explosives for rock excavation shall be as specified in the Contract Documents.

All excavated rock, including rock materials resulting from overbreak and scaling, except the quantity of rock surplus, shall be placed in embankments.

Any excavated rock remaining after constructing the embankments shall be managed as specified in the Management of Excavated Materials clause.

206.07.03.02.01 Rock Excavation - Grading

The work shall include drilling and blasting to obtain the required rock excavation and shatter, mucking, and bringing to grade any overexcavation. Hauling shall only be part of the work when the excavated material is part of the rock surplus or is in excess of the rock embankment requirements.

When rock is to be excavated, all overlying stumps, roots, and vegetation shall be managed as excess material as specified in the Contract Documents. When earth overlies the rock to be excavated, the earth shall be removed. This work shall be performed sufficiently in advance of any blasting or rock excavation operations to allow rock cross-sections to be taken.

Scaling shall be carried out during mucking. All rock fragments or boulders either within or outside the excavated areas that are likely to slide or roll down rock cuts or are otherwise deemed to be unstable by the Contract Administrator shall be removed. Cut ditches shall be excavated at the same time as the main excavation.

Overexcavation in rock cuts shall be brought to grade within the specified tolerances with rock shatter or other approved material at no additional cost to the Owner.

Rock scaling and the removing of all overbreak and scaled materials shall be included in the rock excavation, grading item, unless a rock face item is included in the Contract Documents.

206.07.03.02.01.01 Shale

Shale shall be excavated using methods appropriate for the site conditions. Side slopes in shale shall be as specified in the Contract Documents. Rock face and subgrade shatter are not required in shale.

206.07.03.02.02 Rock Face

The work shall include drilling and blasting using one or more wall control blasting techniques to produce the rock face required in the Contract Documents and all associated scaling, mucking, hauling and management of all overbreak and scaled rock as specified in the Management of Excavated Materials clause.

The Contractor shall decide the required spacing, diameter, and loading of all drill holes for wall control blasting in order to ensure a uniform shear face between the holes and to meet the tolerance requirements stated in the Tolerances for Rock clause for rock face. In no case shall the diameter and spacing of these holes be more than 100 mm and 0.75 m centre-to-centre, respectively,

The Contractor shall also decide the required spacing, diameter, and loading of the adjacent line of production drill holes located inside the controlled blasting limits in order to ensure that wall control blasting is able to produce the required rock face.

However, in no case shall any portion of a production drill hole be within 0.75 m of the line formed by the drill holes for wall control blasting.

206.07.03.03 Excavation for Widening

Excavation that is adjacent to the travelled portion of the roadway shall at no time be in advance of the backfilling operation by a distance greater than the limits as specified in the Contract Documents. Any such excavation shall be backfilled and compacted with material as specified in the Contract Documents, prior to closing down operations each day.

206.07.03.04 Excavation for Pavement Widening

The work shall include excavating a trench adjacent to the existing pavement to the widths and depths as specified in the Contract Documents. Excavated material shall be spread on the adjacent shoulders and slopes.

206.07.03.05 Management of Excavated Materials

Excavated materials shall be used within the Contract limits as specified in the Contract Documents.

When the Contract Administrator has deemed that the Contractor's sequence of operations, inadequate drainage measures, or handling processes or all have caused earth materials that were identified in the Contract Documents as being suitable for embankment or other construction purposes to become unsuitable for such purposes then, at no additional cost to the Owner, the Contractor shall either condition that material until it is suitable or manage it as excess material as specified in the Contract Documents and, if necessary, replace it with an equivalent volume of earth borrow. When the Contractor's operations have caused the material to become unsuitable due to excessive moisture content, conditioning may then involve re-working the material as necessary or spreading out the material in layers or both so that the material is thin enough to allow it to sufficiently dry out.

Quantities of unsuitable earth as specified in the Contract Documents and deemed suitable for use as earth fill by the Contract Administrator at the time of excavation shall be used to offset borrow quantities.

Rock excavated from within the right-of-way (ROW) may be used for aggregate production, in accordance with the RMMP.

Earth or rock that is surplus to embankment requirements may be placed adjacent to the embankments by widening embankments, flattening side slopes, or constructing Berms if optional cross sections or locations or both have been specified for such material in the Contract Documents or as requested by the Contractor and agreed to, in writing, by the Contract Administrator.

Surplus material may only be used within the Contract limits with the written consent of the Contract Administrator.

Surplus materials that cannot be accommodated as above and unsuitable materials shall be managed as excess material as specified in the Contract Documents.

206.07.03.06 Provision for Temporary Cover

Cover used in temporary applications shall be applied according to OPSS 804 to areas as specified in the Contract Documents.

206.07.04 Embankments

Only materials that are specified in the Contract Documents for use in embankments shall be used, unless approved by the Contract Administrator, in writing, prior to placement.

Materials shall not be placed over either frozen earth or ice surfaces. Ice, frozen earth, or other unsuitable materials shall not be incorporated into embankments.

RAP materials used in embankments shall be surplus to the recycling requirements of the Contract.

The Contractor shall notify the Contract Administrator, in writing, when an embankment has been completed to the dimensions that are as specified in the Contract Documents, at least 3 Business Days prior to the Contractor placing any topsoil or any other material on the embankment slopes.

206.07.04.01 Earth Embankments

206.07.04.01.01 General

Material for earth embankments shall be deposited and spread in uniform layers for the full width of the embankment, except as otherwise permitted for berms. Each layer shall be compacted prior to placing the succeeding layer. The lower portion of side hill or sloping sections shall be similarly constructed in layers and compacted until the full width surface of the specified cross-section is obtained. The embankment shall be completed thereafter with full width layers or as staged construction allows.

The construction of a core through the embankment and the subsequent completion of the embankment are prohibited, except when core construction is permitted in swamps according to OPSS 209.

Boulders, cobbles, and fragments of rock, RAP, and RCM over 150 mm in their maximum dimension shall not be placed within 300 mm of the surface of the earth grade.

Boulders, cobbles, and fragments of rock, RAP, and RCM up to 0.5 m^3 may be incorporated into an earth embankment provided:

a) They are placed only in the bottom layer of the embankment.

b) The maximum dimension of the largest particle shall not exceed 800 mm.

c) They are not located within 300 mm of the final embankment side slopes.

d) They are not located within 1.0 m of the surface of the earth grade.

Topsoil placed on earth embankments shall be according to OPSS 802.

Berms may be constructed separately, but shall be completed prior to building the road embankment to a higher level than the berm.

Any excavation necessary for establishing compaction results throughout any embankment or any trial areas such as the one described in the Modified Layer Compaction Method clause shall be done by hand and the excavated areas shall be backfilled with the same material or material otherwise acceptable to the Contract Administrator and properly re-compacted by the Contractor.

206.07.04.01.02 Layer Compaction Method

Earth embankments shall be built using the layer compaction method, unless otherwise specified in the Contract Documents or the requirements specified in the Modified Layer Compaction Method clause have been met.

In the layer compaction method, the embankment material shall be spread out in uniform full width layers not more than 300 mm in depth prior to compaction. Each layer shall be shaped and compacted to the line and cross-section as specified in the Contract Documents prior to the succeeding layer being placed.

All boulders, cobbles, fragments of rock, RAP, and RCM shall have a maximum vertical dimension after placement, not greater than the fully compacted layer depth.

When the ground cannot support construction equipment using this method then, at the discretion of the Contract Administrator, the first layer may be increased in thickness as specified in the Modified Layer Compaction Method clause.

206.07.04.01.03 Modified Layer Compaction Method

When it is impractical to use the layer compaction method, the modified layer compaction method may be used, at the discretion of and with the written consent of the Contract Administrator.

In this case, the embankment material shall be spread out in uniform full width layers not more than 600 mm in depth prior to compaction. Each layer shall be shaped and compacted to the line and cross-section specified prior to the succeeding layer being placed.

All boulders, cobbles, and fragments of rock shall have a maximum vertical dimension when placed not exceeding the modified layer depth. All RAP and RCM shall have a maximum vertical dimension after placement not exceeding 300 mm.

Prior to placing any material, the Contractor shall provide proof to the Contract Administrator of the ability of the proposed method to achieve the specified density by means of a trial section consisting of a single uniform lift covering a minimum area of 400 m^2 as specified in the Trial Section for Modified Layer Compaction Method clause. The location and extent of the trial section shall be acceptable to the Contract Administrator.

Prior to the construction of the trial section, the maximum dry density (MDD) of the material to be compacted shall be determined according to LS-706 from a minimum of 3 independent samples of the material.

Acceptance of the trial section shall be based on compaction testing within the trial section lift. For testing within the lift, the trial section shall be a single lot with 4 sublots of equal area. At a random location within each sublot, a level surface shall be prepared at a depth that permits the probe of a nuclear moisture and density gauge to extend to the bottom of the lift. Field wet density and moisture content shall be determined at each random location using the gauge and the dry density value calculated for each sublot.

If the quality index for the lot, calculated according to the Quality Index clause of OPSS 501, is equal to or greater than 1.47, the trial section shall be accepted. If the quality index for the lot is less than 1.47, the method of construction of the trial section shall not be accepted. The target density for the purpose of the quality index calculation shall be the average of the 3 MDD values determined according to LS-706.

If the trial section has been accepted, field wet density and moisture content testing shall be carried out at 10 random locations on the trial section surface using a nuclear moisture and density gauge. The average dry density from the 10 locations shall be calculated and used as the target density for acceptance, according to OPSS 501, for further placement of the material by the modified layer compaction method.

The same procedure used for the construction of the accepted trial section, including compaction equipment, vibration characteristics, and number of passes, shall be used for the further placement and compaction of the same material by the modified layer compaction method.

A new trial section shall be required for the material when one or more of the following apply:

a) A new target density is required according to the Target Density clause of OPSS 501.

b) The Contractor wants to change the accepted modified layer compaction method procedure.

c) An accepted modified layer compaction method procedure is no longer producing the required degree of compaction.

When requested by the Contract Administrator, compacted material shall be removed to verify the thickness and/or complete compaction testing on a levelled surface within any compacted lift.

All excavation, backfilling, and re-compaction necessary for thickness verification and compaction testing within the trial section lift and as requested by the Contract Administrator at other locations shall be completed to the satisfaction of the Contract Administrator at no additional cost.

206.07.04.02 Rock Embankments

206.07.04.02.01 General

The work shall include hauling, placement, and compaction of excavated rock.

Excavated rock used to construct rock embankments shall be obtained from within the Contract limits. If there is insufficient material to complete the rock embankments, the additional material shall then be provided and paid for under the rock borrow item.

All rock from other items as specified in Contract Documents shall be used to construct rock embankments.

Rock embankments shall be constructed by placing embankment materials full width in successive uniform layers.

For rock embankments, other than shale, the layers shall not exceed 1.5 m in thickness prior to compaction. The material in each layer shall be fully compacted before the succeeding layer is placed. Each rock fill layer shall be compacted with a tractor bulldozer, crawler type, as specified in the Tractor Bulldozer - Crawler Type for Rock Embankment Construction subsection. In confined areas or in any other areas where the Contract Administrator agrees that a tractor bulldozer, crawler type, cannot be reasonably used, then each rock fill layer may be compacted using a hydraulic excavator, crawler mounted, as specified in the Hydraulic Excavator - Crawler Mounted for Rock Embankment Construction subsection. The minimum number of complete passes shall be six and the maximum number of passes shall be eight for either type of equipment. A complete pass shall be defined as 100% coverage of the layer surface. The maximum speed of the equipment during each pass shall be 3.2 km/h.

For all rock embankments, materials shall be placed in their final position by blading when using a tractor bulldozer, crawler type for or by raking and chinking when using a hydraulic excavator, crawler mounted or a combination of both types of equipment, providing that the total number of complete passes over the same area specified in the paragraph given above is achieved. End dumping or depositing of rock over the end of any layer by hauling equipment is not permitted, except as otherwise noted below. Each layer shall be levelled in place and compacted to minimize voids and bridging of large rock fragments within the embankment.

Rock fragments exceeding a maximum of 1.0 m in any dimension shall be well distributed throughout the embankment. Rock fragments up to a maximum of 3.0 m in any dimension may be incorporated into the embankment, provided that the rock fragments are less than two-thirds the remaining embankment height when measured from the bottom of the oversized rock fragment at the point of placement to the top of the rock embankment, and shall be sufficiently spaced to allow free access of the specified equipment to compact the intervening fill.

Placement and compaction in layers is not required when rock is placed under water. In this case, end dumping may be used. However, end dumping shall only be used to an elevation of 1.0 m above the water level that is present at the time of placement. After that, the rock embankment shall be constructed using the equipment and method specified in the paragraphs above. The materials shall be well distributed to form a solid embankment constructed to full width as the work progresses or as staged construction allows.

When a rock embankment is constructed in a wet area such as swamps with full, partial, or no excavation, the direction of the rock placement shall be so that mud waves generated by the rock placement are able to move away from the embankment. Mud waves shall be displaced or removed to prevent their entrapment below or within the embankment.

End dumping from the top of the embankments may also be carried out at locations as specified in the Contract Documents when narrow and relatively shallow widening of an existing embankment is required for the shoulder portion of the highway.

The top surface of the embankment shall be chinked with rock fragments and spalls to form the subgrade prior to the placement of the roadway subbase in order to minimize voids and prevent migration of the subbase material into the rock fill.

Care shall be taken to avoid large boulders and rock fragments protruding above the average embankment surface within a distance of 3.0 m beyond the edge of shoulder.

With the written approval of the Contract Administrator, dumping of surplus rock over the sides of rock embankments by the Contractor is permitted as follows:

a) After the rock embankments have been completed to the grades and tolerances specified in the Contract Documents and all such measurements have been verified by the Contract Administrator.

b) Only in areas that do not affect features that are located within the right-of-way (e.g., ditches, culverts, and signs) or the right-of-way limits and shall not detrimentally affect stability or drainage or cause other potentially negative impacts.

In other areas at the discretion of the Contract Administrator.

206.07.04.02.02 Shale Embankments

Shale embankment materials shall be deposited and spread in uniform layers for the full width of the embankment. Layers shall not exceed 450 mm in thickness prior to compaction. When a harder, more durable rock (e.g., limestone) is present as an integral part of a shale formation, no pieces shall be placed in the embankment that after placement are greater than 150 mm measured vertically or greater than 600 mm measured parallel to the embankment layers, respectively.

Compaction of each layer shall be in two stages using equipment specified in the Rollers for Shale Embankment Construction subsection. In the first stage, a minimum of 2 passes shall be made with a static sheepsfoot, packall, padfoot, or tamping foot type roller. In the second stage, a minimum of 2 passes shall be made with a vibratory steel drum or pneumatic-tired roller. The maximum speed of rollers shall not exceed 5 km/hr.

206.07.05 Rock Backfill to Structure

When rock backfill to structures is specified, the rock backfill shall only be comprised of rock fragments with maximum dimensions no larger than 250 mm and free of all debris, earth, topsoil, wood, chemical, or other contamination.

Rock backfill shall be placed in a manner that the structure is not damaged. Dumping of rock backfill against a structure shall not be permitted.

206.07.06 Quality Control

206.07.06.01 Grade Checks

The Contractor shall be responsible for carrying out all quality control (QC) grade checks to ensure that horizontal and vertical grading tolerances are met.

A competent surveyor shall carry out grade checks on all finished earth and rock grade surfaces. QC of earth and rock grade surfaces shall be based on horizontal and vertical grading tolerances as specified in the Tolerances for Earth and Tolerances for Rock clauses, respectively. The grade shall be certified at the stations and offsets shown in the grading templates or where grading templates are not available, at the frequency requirements specified for the layout elsewhere in the Contract Documents.

206.07.06.01.01 Submission of Grade Checks

The Contractor shall submit all grade checks relating to horizontal and vertical grading tolerances, including all non-compliances, to the Contract Administrator within 2 Business Days following completion of the grade.

When a digital terrain model is available, the Contractor has the option to provide the grade checks in the same format accompanied with a signed cover letter certifying that the components of the work indicated on the digital terrain model have been correctly constructed to the specified line and grade tolerances.

Alternatively when grading templates are available, the Contractor shall sign and certify on the grading template that the components of the work indicated on that template have been correctly constructed to the specified line and grade tolerances.

If a digital terrain model or template is not available, then the Contractor shall complete, sign, and submit the attached form OPSF 206-1 to the Contract Administrator.

206.07.06.02 Compaction Quality Control

The Contractor shall use Method B according to OPSS 501 for quality control of compaction.

206.07.07 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

206.08 QUALITY ASSURANCE

206.08.01 Grade Checks

The Owner may conduct random QA grade checks to verify horizontal and vertical grading tolerances.

Provided that the Owner's grade checks conform to those submitted by the Contractor, no action shall be taken. If discrepancies between QA and QC grade checks occur, the Owner may then conduct additional QA grade checks at the Owner’s discretion.

If the finished grade or cross-section is found to be outside the specification limits specified in the Tolerances - General clause, then:

a) The Contract Administrator shall notify the Contractor.

b) The Contractor shall then bring the earth or rock grade surface to within the specified tolerances for grade, at no additional cost to the Owner.

206.09 MEASUREMENT FOR PAYMENT

206.09.01 Actual Measurement

206.09.01.01 Earth Excavation, Grading

Measurement for earth excavation, grading, shall be the in-place volume of earth in cubic metres computed from field measurements of cross-sections taken both prior to grubbing and upon completion of the work.

When benching is required to key-in new fills into existing slopes, the quantity of materials that are excavated as part of that operation shall not be included in the measurement for payment.

206.09.01.01.01 Overbuilding, Earth

When the Contract requires earth borrow, the quantity of material placed beyond the earth grading tolerances shall be deducted from the measured quantity of earth borrow on a cubic metre for cubic metre basis, with no correction for changes in the density of the material.

206.09.01.02 Excavation for Pavement Widening

Measurement of excavation for pavement widening shall be the horizontal length in metres along each edge of the existing pavement when widening is specified in the Contract Documents.

206.09.01.03 Rock Excavation, Grading

206.09.01.03.01 General

Measurement of rock excavation, grading, shall be the in-place volume in cubic metres computed from field measurements of cross-sections bounded by the original rock line after the earth overburden has been removed and the theoretical rock face and the bottom excavation limits designated in the Contract Documents. Where shatter is specified, the bottom of the cut shall be 300 mm below the designated rock grade.

The quantity of rock excavation shall also include:

a) All shatter that is specified in the Contract Documents.

b) Any rock that is excavated beyond the limits that are as specified in the Contract Documents at the Contract Administrator's written instructions.

206.09.01.03.02 Overbuilding, Rock

Where the Contract requires borrow, the quantity of material placed beyond the rock grading tolerance at the top of subgrade and beyond the angle of repose for rock fills, below the subgrade, shall be deducted from the measured quantity of borrow on a cubic metre for cubic metre basis, with no correction for changes in density of the material.

206.09.01.03.03 Boulders

Measurement of each boulder classified as rock shall be by volume in cubic metres computed on the basis of the product of the actual rock measurement of the 3 maximum rectilinear dimensions in metres of the boulder.

206.09.01.04 Rock Face

Measurement of rock face shall be by area of the rock face in square metres.

206.09.01.05 Rock Embankment

Measurement of rock embankment shall be by volume in cubic metres of rock embankments. Adjustments to the Plan Quantity shall be limited to those supported with topographic survey information.

206.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

206.10 BASIS OF PAYMENT

206.10.01 Earth Excavation, Grading - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

Payment for earth grade checks, including provision of all labour, Equipment, and Material to conduct quality control testing shall be included in the Contract price as part of the work of earth excavation, grading.

206.10.02 Excavation for Pavement Widening - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

When the Contract Administrator directs that material excavated under this item is to be handled other than as specified in the Excavation for Pavement Widening clause, then such material shall be managed in accordance with the Contract Documents and treated as a Change in the Work.

Material used to backfill the excavation shall be paid for at the Contract price for the tender item of the type of material used.

206.10.03 Rock Excavation, Grading - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

When a rock face item is not included in the Contract, rock scaling and the removing of all overbreak and scaled materials shall be included in the rock excavation, grading item.

When a rock embankment item is not included in the Contract, the work of rock embankment shall be included in the rock excavation, grading item.

When excavated rock is to be used for any other Contract item work (e.g., rock embankment, granular materials, or rip-rap), the hauling costs are deemed to be included in payment for the work associated with the appropriate tender item. However, when excavated rock is not to be used for any other Contract item work, the hauling costs are then deemed to be included in payment for the work under the rock excavation, grading item.

Payment for rock grade checks, including provision of all labour, Equipment, and Material to conduct quality control testing, shall be included in the Contract price as part of the work of rock excavation, grading.

When drilling, blasting, and mucking are required as a part of the work for this tender item, the following progress payments shall be made:

a) 33% of the progress volume for drilling.

b) 33% of the progress volume for blasting.

206.10.04 Rock Face - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

On completion of drilling and blasting, a progress payment of 50% of this tender item shall be made.

On completion of mucking, a progress payment of an additional 25% of this tender item shall be made.

When the Contract does not contain a separate tender item for rock face, the Contract price for rock excavation, grading, shall include full compensation for all labour, Equipment, and Material to do the work of rock face.

206.10.05 Rock Embankment - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

When the Contract does not contain a separate tender item for rock embankment, the Contract price for rock excavation, grading shall include full compensation for all labour, Equipment, and Material to do the work of rock embankment.

206.10.06 Backfill for Overexcavation

Payment shall not be made for backfill of any overexcavation in excess of the specified tolerances.

206.10.07 Backfill for Subexcavation

Material used to backfill subexcavations and transition or grade point treatments shall be paid for at the Contract price for the tender item of material used.

206.10.08 Rock Borrow

When the Contract does not contain sufficient rock within the Contract limits and the Contract does not contain a rock embankment item, rock borrow shall be paid according to OPSS 212.

CERTIFICATION OF GRADE ELEVATION / CROSSFALL

CONTRACT _____ **LOCATION** _____

COMPONENTS _____ **LOCATION** _____

In compliance with the contract, I hereby certify that the following component of the work has been correctly constructed to the specified line and grade tolerances.

FROM STATION	TO STATION	TYPE OF GRADE (base, subbase, earth, rock, culvert etc.)	DATE	SIGNATURE

OPSF 206-1

Appendix 206-A, April 2019
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

Consider using OPSS.PROV 206 when rock excavation volumes is in excess of 10,000m^3.

The designer should specify the following in the Contract Documents:

- Locations for use of excavated material. (206.07.03.05)
- Areas requiring temporary cover. (206.07.03.06)
- Location and extent of unsuitable material below subgrade to be removed. (206.07.03.01.03)
- The stripping limits. (206.07.03.01.02)
- The maximum limit of open excavation allowed adjacent to the travelled roadway. (206.07.03.03)
- The widths and depths when excavation is required adjacent to the travelled roadway. (206.07.03.04)

The designer should determine if the following is required and, if so, specify it in the Contract Documents:

- Rock material management plan. (206.04.01.01)
- Borrow requirements. (206.07.01.03)
- Rock face item. (206.07.03.02.02)
- Rock embankment item. (206.10.05)
- Where the Modified Layer Compaction Method may be used. (206.07.04.01.03)
- Location of where end dumping material is allowed. (206.07.04.02.01)

The designer should be aware that in estimating fill quantities, where displacement may be anticipated, an allowance should be made for losses into bottom of fills in material due to displacement.

Consideration should be given to the use of trial blast over a limited extent to ensure that the method spacing and diameter wall control blast holes are properly selected to achieve an acceptable rock face for the given rock condition.

On reconstruction projects, areas of subgrade shatter, rock fill, and previously blasted rock to be removed should be clearly defined in terms of location, depth, etc.

When a rock embankment item is not included in the Contract, the designer should include a rock borrow item if there is insufficient rock within the Contract limits.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Appendix 206-A

Related Ontario Provincial Standard Drawings

OPSD 200.010	Earth/Shale Grading, Undivided Rural
OPSD 200.020	Earth/Shale Grading, Divided Rural
OPSD 201.010	Rock Grading, Undivided Rural
OPSD 201.020	Rock Grading, Divided Rural
OPSD 202.010	Slope Flattening Using Excess Material on Earth or Rock Embankment
OPSD 202.020	Drainage Gap for Slope Flattening on Rock or Granular Embankment
OPSD 202.030	Embankment Widening for Guide Rail End Treatments and Transitions
OPSD 203.010	Embankments Over Swamp, New Construction
OPSD 203.020	Embankments Over Swamp, Existing Slope Excavated to 1H:1V
OPSD 203.030	Embankments Over Swamp, Existing Slopes Maintained
OPSD 203.040	Embankments Over Swamp at Pipe Culverts $\leq$ 1500mm
OPSD 204.010	Boulder Treatment, Cut Sections - Subgrade
OPSD 205.010	Transition Treatment, Earth Cut to Earth Fill
OPSD 205.020	Transition Treatment, Rock Cut to Rock Fill
OPSD 205.030	Transition Treatment, Rock Cut to Earth Fill
OPSD 205.040	Transition Treatment, Earth Fill to Rock Fill and Earth Fill to Granular Fill
OPSD 205.050	Transition Treatment, Rock Cut to Earth Cut
OPSD 205.060	Frost Heave Treatment
OPSD 208.010	Benching of Earth Slopes
OPSD 209.010	Rural Pavement Widening
OPSD 209.011	Rural Pavement Widening with Curb and Gutter
OPSD 209.020	Widening, Existing Rock Cut with Grade Raise
OPSD 300.010	Side Road Intersection, Fill
OPSD 300.020	Side Road Intersection, Cut
OPSD 301.010	Rural Entrances to Roads on Fill
OPSD 301.020	Rural Entrances to Roads in Earth Cut With Culvert Installation
OPSD 301.030	Rural Entrance, Rock Cut

CONSTRUCTION SPECIFICATION FOR EMBANKMENTS OVER SWAMPS AND COMPRESSIBLE SOILS

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209-A **Commentary**

209.01 SCOPE

This specification covers the requirements for the construction of embankments over swamps and compressible soils using the excavation, floatation, or displacement method.

209.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

209.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

209.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 201	Clearing, Close Cut Clearing, Grubbing, and Removal of Surface and Piled Boulders
OPSS 206	Grading
OPSS 212	Borrow

Ontario Provincial Standard Specifications, Material

OPSS 1010	Aggregates - Base, Subbase, Select Subgrade, and Backfill Material
OPSS 1860	Geotextiles

209.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Displacement Method means to build the embankment directly on the swamp such that the underlying swamp material is displaced away from the embankment fill.

Earth means as defined in OPSS 206.

Floatation Method means to build the embankment directly on the swamp minimizing the displacement of the swamp material.

Rock means as defined in OPSS 206.

Hydraulic Backhoe Reach means the distance from the bottom of the tracks to the tip of the bucket teeth when measured vertically with the bucket at the lowest point of the bucket swing path.

Swamp Material means the material within the swamp excavation, floatation, or displacement limits, except rock, masonry, natural wood, and manufactured products. Wood that has decomposed and breaks down readily upon handling shall be considered swamp material.

Swamp Wave means the swamp material that is displaced as a result of placement of embankment material.

209.05 MATERIALS

209.05.01 Embankment Material

Embankment material shall consist of earth, rock, select subgrade material, or other material specified in the Contract Documents.

209.05.01.01 Earth Borrow or Rock Borrow

Earth borrow or rock borrow shall be according to OPSS 212.

209.05.01.02 Select Subgrade Material

Select subgrade material shall be according to OPSS 1010.

209.05.02 Geotextile

Geotextile shall be according to OPSS 1860 and be of the type, class, and filtration opening size (FOS) range specified in the Contract Documents.

209.06 EQUIPMENT

209.06.01 Rented Swamp Excavator

The type of swamp excavator equipment shall be as specified in the Contract Documents.

The minimum size and requirements shall be a 26,500 kg crawler mounted hydraulic backhoe with a minimum 12 m reach and a 1 m^3 bucket or a 40,000 kg crawler mounted dragline with a 1.15 m^3 bucket. Buckets shall be suitable for swamp excavation.

209.06.02 Spreading, Levelling, and Compacting Equipment

When the floatation method is used, spreading, levelling, and compacting equipment shall be restricted to a gross weight that is not detrimental to the structural integrity of the root mat.

209.07 CONSTRUCTION

209.07.01 General

The work of embankment construction shall be carried out using one or more of the following methods specified in the Contract Documents:

a) Excavation Method

b) Floatation Method

c) Displacement Method

209.07.02 Clearing and Close Cut Clearing

Prior to beginning embankment construction, the required clearing and close cut clearing shall be completed according to OPSS 201. Close cut clearing shall be carried out in such a manner as not to damage the structural integrity of the root mat.

209.07.03 Excavation Method

The work shall include the excavation of all material, except rock from within the limits specified in the Contract Documents and the handling, placing, shaping, trimming and hauling of excavated material.

Excavation shall be to the full width and full depth. The excavation and backfilling shall be a controlled operation and shall be carried out simultaneously.

Excavated material shall be placed clear of the sides of the embankment limits and any drainage facilities.

209.07.03.01 Embankment Construction and Backfill

Backfill shall be placed according to OPSS 206. However, when wet conditions exist, backfill material other than rock may be placed up to 600 mm above water level without compaction.

Embankment material placed subsequent to the backfill material shall be placed according to OPSS 206.

209.07.04 Floatation Method

The work shall consist of controlled placement of embankment material, removal of surcharges specified in the Contract Documents from above the subgrade, and hauling and incorporating of the surcharge material into the work according to OPSS 206.

209.07.04.01 Swamp Waves

Swamp waves shall not be excavated or otherwise disturbed.

209.07.04.02 Embankment Construction

The embankment shall be constructed according to OPSS 206, except that vibratory compaction equipment shall not be used within 1.0 m of the original surface of the swamp.

Each layer shall be built using an outside to inside sequence by keeping the outer one-third portions of the layer at least 30 m ahead of the centre portion.

209.07.04.03 Geotextile

When geotextile is to be placed, the area specified in the Contract Documents for geotextile shall be close cut cleared and cleared of objects that may damage the geotextile.

The placement operation shall be such that the geotextile is not exposed to daylight for more than 72 hours.

Adjacent sections of the geotextile shall be overlapped a minimum of 1.0 m or shall be sewn together according to OPSS 1860.

Where geotextile is damaged, it shall be repaired by the removal of the embankment material and placing a piece of geotextile large enough to cover the damaged section meeting the above requirements for overlapping.

209.07.05 Displacement Method

The work shall consist of controlled placement of the embankment material, excavation of swamp waves and displaced material, removal of surcharges specified in the Contract Documents, and hauling and incorporating of this material into the work according to OPSS 206.

209.07.05.01 Embankment Construction

The embankment shall be built in such a manner as to displace as much of the material underlying the embankment as possible. An inside to outside construction sequence shall be used, keeping the inside one-third portion 30 m ahead of the outside portions.

When a stable platform has been established, embankment material placed 300 mm above the original surface of the swamp shall be placed according to OPSS 206.

209.07.06 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

Manufactured products shall not be used in the right-of-way.

Excavated swamp material shall be used as much as possible within the right-of-way adjacent to an embankment and conforming to standard right-of-way offset. This shall be done by widening embankments, flattening side slopes, and constructing modified cross-sections as specified in the Contract Documents. Such material shall be trimmed to provide smooth contours and to provide drainage.

The volume of excavated material to be used within the Contract limits or designated areas shall be as specified in the Contract Documents.

209.09 MEASUREMENT FOR PAYMENT

209.09.01 Actual Measurement

209.09.01.01 Excavation

Measurement shall be by volume in cubic metres by the method of average end areas. The quantity for payment shall be the lesser of the following:

a) Actual excavation.

b) Excavation to the length, width, and depth as specified in the Contract Documents.

209.09.01.02 Rental of Swamp Excavation Equipment

Measurement shall be by time in hours that the equipment is in effective operation. When hauling is required, the equipment shall not be considered in effective operation when there are no trucks ready for loading.

When the excavated material has been placed in a location that will not interfere with subsequent excavation, measurement shall not be made for the handling required in grading, levelling, and trimming of such material.

209.09.01.03 Select Subgrade Material

Measurement shall be by mass in tonnes or by volume in cubic metres as specified in the Contract Documents.

209.09.01.03.01 Cubic Metre Measurement

When measurement of select subgrade material is in cubic metres, one of the following methods, as specified in the Contract Documents, shall be used to calculate the volume of the material:

a) End Area Method

Volume of material shall be measured in its original location and computed in cubic metres by the method of average end areas.

Original cross-sections shall be taken after the area has been cleared, grubbed, and stripped of unsuitable surface material. These operations shall be completed a minimum of 3 Working Days in advance of excavation to allow for the required cross-sectioning.

b) Truck Box Method

Material shall be measured in cubic metres, loose, by predetermined truck box capacities. The predetermined capacity of each truck shall be that computed from its box dimensions.

Each truck shall be uniquely and readily identifiable.

209.09.01.04 Geotextile

Measurement shall be by area, in place, in square metres, with no allowance for overlaps.

209.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

209.10 BASIS OF PAYMENT

209.10.01 Excavation

Payment for swamp excavation shall be at the Contract price for the tender item Earth Excavation, Grading, according to OPSS 206.

Payment shall not be made for the removal of materials that slide or slough inside the excavation limits.

209.10.02 Rental of Swamp Excavation Equipment, Dragline - Item
Rental of Swamp Excavation Equipment, Hydraulic Backhoe - Item

Payment at the Contract price for the above tender items shall be full compensation for furnishing and operating the minimum size equipment specified, including mats, when necessary, for the excavation and for the management of the material adjacent to the excavation.

Payment for drainage of water in swamps prior to excavation is included in these tender items unless otherwise specified elsewhere in the Contract Documents.

When the Contract Administrator approves the use of larger equipment, the Contract price per hour shall be adjusted by adding to the Contract price the difference between the rate set out in the Contract Documents for the minimum size equipment specified and the rate set out in the Contract Documents for the larger equipment to be employed.

Where the standard operating weight for the equipment falls between increments and listed categories shown in the Contract Documents the lower rate shall apply. No interpolation between categories of standard operating weights will be made to determine payments. When larger equipment is approved for use, the estimated hours of swamp excavation equipment rental will be adjusted down by the Contract Administrator.

209.10.03 Floatation and Displacement Method

Payment shall not be made for swamp material displaced by floatation or displacement.

209.10.04 Select Subgrade Material - Item
Geotextile - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Repairs to geotextile damaged by the Contractor's operation shall be at no additional cost to the Owner.

209.10.05 Management of Swamp Material Excavated by Equipment Rental

All costs associated with the management of material except trucking are deemed to be included in the Contract unit price for rental of equipment.

Material resulting from the operation of the above equipment shall be managed as specified in the Contract Documents.

Appendix 209-A, November 2015
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Alternative materials allowed in embankment construction (e.g., expanded polystyrene, wood chips, bark, and granular blast furnace slag). (209.05.01)

- Woven or non-woven, class of fabric, FOS, and thickness of material for geotextile. (209.05.02)

- One or more of the methods of embankment construction. (209.07.01)

- Maximum volume and locations of excavated material to be placed within the Contract limits. (209.07.07)

- Method of measurement for select subgrade material. (209.09.01.03)

- Method of calculation for cubic metre measurement, if required. (209.09.01.03.01)

The designer should determine if the following is required and, if so, specify it in the Contract Documents:

- Type of rental swamp excavation equipment. (209.06.01)

The designer should include the rental of swamp excavation equipment item when recommended by an Engineer.

The designer should specify whether payment for drainage of water in swamps is included in the rental of swamp excavation equipment item or included as a separate item.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standards Drawings

OPSD 203.010	Embankments Over Swamp, New Construction
OPSD 203.020	Embankments Over Swamp, Existing Slopes Excavated to 1H:1V
OPSD 203.030	Embankments Over Swamp, Existing Slopes Maintained
OPSD 203.040	Embankments Over Swamp at Pipe Culverts ≤ 1500 mm

CONSTRUCTION SPECIFICATION FOR BORROW

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212-A **Commentary**

212.01 SCOPE

This specification covers the requirements for earth borrow and rock borrow.

212.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

212.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

212.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 201	Clearing, Close Cut Clearing, Grubbing, and Removal of Surface and Piled Boulders
OPSS 206	Grading
OPSS 401	Trenching, Backfilling, and Compacting

Ontario Ministry of Transportation Publications

MTO Laboratory Testing Manual:

LS-702	Determination of Particle Size Analysis of Soils

MTO Form:

PH-D-10	Aggregate Sample Data Sheet

212.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Access Road means a private road built or an existing road used by the Contractor to gain access to the Work or to a source of material.

Borrow means earth or rock material acquired from outside the right-of-way to complete the Work.

Haul Road means any public road, excluding the road under Contract, that forms part of a material haul route.

Referee Testing means testing of a material attribute for the purpose of resolving acceptance issues at the request of the Contractor or the Owner.

212.04 DESIGN AND SUBMISSION REQUIREMENTS

212.04.01 Submission Requirements

A minimum of 14 Days prior to earth borrow material being used in the Work, a list of intended borrow sources and the tonnage that is expected to be used from each source shall be provided to the Contract Administrator to allow time for sampling and testing.

A minimum of 48 hours prior to the placement of borrow in the Work, the following shall be submitted to the Contract Administrator:

a) Written proof for the right to occupy and operate each borrow source, including all appropriate permits.

b) Identification and description of any frost-susceptible materials intended for use as borrow and a detailed plan describing where it would be placed.

212.05 MATERIALS

212.05.01 Earth Borrow

Earth borrow shall consist of earth or shale as defined in OPSS 206 and shall be free from organic and foreign material.

Earth borrow with at least 50% of its particles by mass between 5 and 75 µm in size, as determined using LS-702, shall be considered frost-susceptible.

212.05.02 Rock Borrow

Rock borrow shall consist of rock as defined in OPSS 206, excluding shale.

212.07 CONSTRUCTION

212.07.01 General

The work required for borrow shall include clearing, grubbing, and stripping of a borrow source according to OPSS 201 and 206; construction and maintenance of access roads; maintenance and restoration of haul roads, as a result of the Contractor hauling borrow; excavating, hauling, placing, and compacting borrow; and borrow source rehabilitation.

The construction of embankments and backfill areas with borrow shall be according to OPSS 206 and OPSS 401, respectively.

Frost-susceptible material shall not be placed in the following areas:

a) Within the zone between the frost penetration depth specified elsewhere in the Contract Documents and the final grade that will be established within the roadway upon completion of construction.

b) In any other areas, specified elsewhere in the Contract Documents.

When borrow is stockpiled prior to use, material from different sources shall be stockpiled separately from each other.

212.07.02 Owner's Properties

Unless otherwise specified, material shall not be supplied from the Owner's properties.

212.07.03 Clearing, Grubbing, and Stripping

Borrow sources shall be cleared, grubbed, and stripped of any unsuitable materials. These operations shall be completed a minimum of three Working Days in advance of any excavation where cross-sections are required.

Stripped material shall be piled sufficiently back from the face of the pit or quarry to prevent the contamination of the face material. The stripped material shall be piled such that the distance from the face being worked to the stripped material shall be:

a) For pits, at least equal to the depth of the face or 5 m, whichever is the greater distance.

b) For quarries, at least 5 m.

212.07.04 Haul Roads

Inspection of all haul roads prior to construction use shall be undertaken jointly by the Contract Administrator, the Contractor, and the owner of the haul road.

All required restoration work shall be performed when haul roads are damaged due to hauling operations.

Acceptable material shall be chosen and properly placed on the haul road to:

a) Provide safe passage and control of traffic at all times; and

b) Repair that road to the pre-contract condition upon completion of the hauling operations both to the satisfaction of the Contract Administrator and the owner of the road.

212.07.05 Borrow Source Rehabilitation

The borrow source shall be rehabilitated to comply with all applicable federal, provincial, and municipal requirements.

212.07.06 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

212.08 QUALITY ASSURANCE

212.08.01 General

The Contract Administrator reserves the right to visually inspect borrow and reject any borrow material that does not meet the requirements specified herein and elsewhere in the Contract Documents.

All samples shall be obtained and delivered to the QA laboratory according to the Contract Documents. The data to be included with all samples shall be according to the requirements of the MTO form PH-D-10.

212.08.02 Acceptance of Earth Borrow

At the discretion of the Owner, the Quality Assurance (QA) laboratory designated by the Owner may carry out QA testing for the purposes of ensuring that earth borrow being placed above the frost penetration depth in the areas listed in the General subsection of the Construction section is not frost-susceptible.

For earth borrow material being placed within the frost penetration depth in the areas specified above, lots may be established at the discretion of the Contract Administrator, in accordance with the schedule shown in Table 1. In addition, any single lot or series of lots may be terminated and a new lot or series of lots re-established, at the discretion of the Contract Administrator.

A minimum of one randomly-obtained duplicate sample shall be obtained from each lot. Additional samples may also be taken at the discretion of the Contract Administrator. In the event that the Contractor is unavailable to take a designated sample for a lot, then no further earth materials from that lot shall be placed above the frost penetration depth until the designated sample is taken.

The Contract Administrator shall document and seal each sample container according to the Contract Documents.

For each duplicate sample, one sample shall be tested for QA purposes and the remaining sample shall be retained for referee testing, if necessary.

If a sample is found to contain more than 50% of its particles by mass between 5 and 75 µm when tested in accordance with LS-702, the Contract Administrator shall then notify the Contractor, in writing, within two Business Days of receiving the results, that any material within that lot represented by that sample including any material already within the Work or in stockpiles is frost susceptible and not acceptable for use above the frost penetration depth, wherever specified in the Contract Documents.

In addition, any of the material within that lot which has already been placed within the areas listed in the General subsection of the Construction section shall be removed at no additional cost to the Owner.

212.08.02.01 Referee Testing

The Contractor may invoke referee testing for any lot by submitting a written request to the Contract Administrator within two Business Days following notification from the Contract Administrator that the sampled material has been determined to be frost-susceptible.

The retained duplicate QA sample shall be used for referee testing. However, if a referee sample is not available, the Contractor shall then be responsible for obtaining a new sample from a location to be decided on by the Contract Administrator, at no additional cost to the Owner.

Referee testing shall be carried out in the presence of the Contract Administrator. The Contractor may observe the testing. Owner and Contractor observers shall be permitted to validate sample identification, view sample condition, observe test procedures, take notes, view equipment readings, and review completed work sheets while in attendance. Concerns with sample condition or sample identification shall be made prior to commencement of referee testing. Comments on deviations from the applicable test method shall be made immediately and corrected at the time of testing. Unresolved concerns shall be specific in nature and submitted in writing to the laboratory's designated representative and other observers at the time of testing. Referee test results for a lot shall replace the respective QA tests for acceptance of the applicable lot and the referee results shall be binding on both the Owner and the Contractor.

212.09 MEASUREMENT FOR PAYMENT

212.09.01 Actual Measurement

212.09.01.01 Earth Borrow and Rock Borrow

Measurement of earth borrow and rock borrow shall be by mass in tonnes or by volume in compacted cubic metres as specified in the Contract Documents.

When earth borrow and rock borrow is measured by volume, one of the following methods, as specified in the Contract Documents, shall be used to calculate the volume of the material:

a) End Area Method

i. In Place

The compacted material shall be measured at the Contract site using the method of average end areas and surveyed cross-sections taken both prior to and after the placement of the material in the Work.

ii. At Source

Material shall be measured at the source in its original location by the method of average end areas.

Cross-sections shall be taken after the source has been cleared, grubbed, and stripped of all unsuitable surface material.

The volume of any boulders that cannot be accommodated in the Work shall be deducted.

b) Truck Box Method

For borrow quantities that are less than 1,000 m^3, in areas where surveying may be impractical such as where borrow is being placed in areas of standing water, or where materials that are not designated as borrow are being placed and compacted in the same area and at the same time as borrow, then the truck box method may be used, at the discretion of the Contract Administrator.

In this case, each truck carrying borrow shall be readily-identifiable and the loose volume that it contains shall be calculated based on an estimated percentage of the truck box capacity which has been pre-determined from measurements taken by the Contract Administrator. The Contract Administrator shall then determine the compacted in-place volume of the borrow by dividing the estimated volume of the material within the truck box by an appropriate bulking factor determined by the Owner.

212.10 BASIS OF PAYMENT

212.10.01 Earth Borrow - Item
Rock Borrow - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Removal and replacement of localized soft spots identified by the Contract Administrator or removal of unacceptable material or both shall be at no additional cost to the Owner.

The Owner shall be responsible for the cost of referee testing, provided that the referee test results show that the material meets the applicable specifications. Otherwise, the Contractor shall be responsible for the costs.

212.10.02 Haul Roads

Payment at the Contract price for the appropriate tender items used to perform maintenance and restoration of haul roads shall be full compensation for all labour, Equipment, and Material to maintain and restore haul roads.

When the Contract does not include the appropriate tender items, prices shall be negotiated.

212.10.03 Access Roads

No separate or additional payment shall be made for the cost of construction and maintenance of access roads.

TABLE 1
Lot Schedule for Sampling and Testing Earth Borrow
Placed Above the Frost Penetration Depth

Expected Quantity from Each Source (m^3)	**Lot Size**
< 10,000	One lot
≥ 10,000 (Note 1)	10,000 m^3 lots up to 50,000 m^3 and 50,000 m^3 lots thereafter

Notes:

1. When the quantity of borrow is insufficient for a complete lot and is:

a) less than one-half the quantity of a complete lot, then that quantity shall be added to the previous lot; or

b) greater than or equal to one-half the quantity of a complete lot, then that quantity shall form its own lot.

Appendix 212-A, November 2019
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer shall specify the following in the Contract Documents:

- Frost penetration depth. (212.07.01)

- Areas where frost-susceptible borrow is not to be placed. (212.07.01)

- Who delivers the QA samples to the QA laboratory. (212.08.01)

- The method of measurement for earth borrow and rock borrow. (212.09.01.01)

- The method of calculation of volume of material if measurement is by volume. (212.09.01.01)

All acceptable fill material should be considered for embankment construction, prior to selecting either earth borrow or rock borrow as a construction alternative.

The designer should determine if material from Owner sources is available and, if so, the designer should specify this information in the Contract Documents. (212.07.03)

When borrow sources are known, they should be identified in the Contract Documents.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

CONSTRUCTION SPECIFICATION FOR WICK DRAIN INSTALLATION

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220.09 **MEASUREMENT FOR PAYMENT**

220.10 **BASIS OF PAYMENT**

APPENDICES

220-A **Commentary**

220.01 SCOPE

This specification covers the requirements for the supply and installation of wick drains, including granular blanket.

220.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

220.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

220.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 206	Grading
OPSS 501	Compacting

Ontario Provincial Standard Specifications, Material

OPSS 1010	Aggregates - Base, Subbase, Select Subgrade, and Backfill Material

Canadian General Standards Board (CGSB)

148.1 No. 10-94	Methods of Testing Geosynthetics - Geotextiles - Filtration Opening Size

ASTM International

D3776/D3776M-20	Standard Test Methods for Mass per Unit Area (Weight) of Fabric
D4491/D4491M-21	Standard Test Methods for Water Permeability of Geotextiles by Permittivity
D4533/D4533M-15	Standard Test Method for Trapezoid Tearing Strength of Geotextiles
D4632/D4632M-15a	Standard Test Method for Grab Breaking Load and Elongation of Geotextiles
D4716/D4716M-20	Standard Test Method for Determining the (In-plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head
D5199-12 (2019)	Standard Test Method for Measuring the Nominal Thickness of Geosynthetics

D5261-10 (2018)	Standard Test Method for Measuring Mass per Unit Area of Geotextiles
D6241-14	Standard Test Method for Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe
D638-14	Standard Test Method for Tensile Properties of Plastics

220.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Certificate of Conformance means a form issued by an Engineer confirming that the specified components of the Work are in general conformance with the Contract Documents as shown in OPSF 539-1.

Geotechnical Instrumentation means equipment used to monitor the progress of settlement, displacement, and pore water pressure measurements and includes such equipment as piezometers, settlement cells, standpipes, settlement profilers, inclinometers, and settlement rods.

Granular Blanket means a layer of free draining granular material used to provide drainage of excess pore pressures due to soil consolidation.

220.04 DESIGN AND SUBMISSION REQUIREMENTS

220.04.01 Submission Requirements

220.04.01.01 Qualifications

The installation of the wick drains shall be performed by a recognized specialist with proven satisfactory experience in work of this type and magnitude and shall have completed a minimum of 5 wick drain installation projects in the last 5 years. Prior to the commencement of the Work, the qualifications of the recognized specialist shall be submitted to the Contract Administrator.

220.04.01.02 Materials

At least 3 weeks prior to the installation of wick drains, the following shall be submitted to the Contract Administrator:

a) A minimum one metre sample of the wick drain.

b) The manufacturer’s technical specifications indicating that the materials meet the requirements shown in Table 1.

c) A certificate for each production lot supplied indicating that the wick drain supplied was produced and tested according to the requirements shown in Table 1.

QC test results shall be available for the granular material to be used in the granular blanket. Quality control test results shall be submitted or made available at the request of the Contract Administrator. When more than one aggregate source is used for supplying material, test data from each source shall be submitted separately.

220.04.01.03 Installation Procedures

At least 3 weeks prior to the installation of wick drains, the details of the sequence and method of installation outlining the following shall be submitted to the Contract Administrator:

a) Size, type, weight, maximum pushing force, and configuration of the installation rig.

b) Dimensions of the mandrel to be used.

c) Details of wick drain anchorage.

d) Detailed description of proposed installation procedures.

e) Method to penetrate all subsoils.

f) Alternative methods for overcoming obstructions.

g) Methods for splicing wick drains.

220.05 MATERIALS

220.05.01 Wick Drains

Wick drains shall be prefabricated and shall consist of a continuous plastic drainage core wrapped in a non-woven geotextile. The geotextile, core, and composite wick drain shall meet the requirements shown in Table 1.

All wick drains shall be free of defects, rips, holes, and flaws.

220.05.02 Granular Blanket

The granular blanket shall be Granular B, Type I, Type II, or Type III, according to OPSS 1010, except that 100% shall pass the 37.5 mm sieve.

220.06 EQUIPMENT

220.06.01 GENERAL

The equipment used to install wick drains shall be of the type that minimizes the disturbance to the drainage blanket or the native subsoil during the installation operation.

Falling weight impact hammers shall not be permitted.

220.07 CONSTRUCTION

220.07.01 Operational Constraints

When a site is designated as an environmentally sensitive area, jetting techniques shall not be permitted.

Wick drains shall be installed subsequent to the construction of the granular blanket and prior to the installation of monitoring instruments and placement of any overlying material.

Wick drains shall be protected by a minimum of 2 m of earth fill or 4 m of rock fill before the ground freezes. Wick drains shall not be installed in frozen ground. The installation activity shall be planned, organized and scheduled to avoid wick drain installation in frozen ground.

Installation of the wick drains shall be coordinated with the placement of geotechnical instrumentation as specified in the Contract Documents. Wick drains shall be installed in a manner that does not disturb geotechnical instrumentation already in place. Geotechnical instrumentation damaged as a result of Contractor's activities shall be replaced at no additional cost to the owner.

220.07.02 Transportation and Storage

During transportation and storage, the wick drain materials shall be protected from damage.

The storage area shall be so that the wick drain materials are protected from sunlight, dirt, dust, mud, debris, and all other detrimental substances.

220.07.03 Granular Blanket

The granular blanket shall be placed subsequent to the excavation of unsuitable material and any backfilling specified in the Contract Documents.

The granular blanket shall be placed and compacted to the limits and grades specified in the Contract Documents.

The granular blanket shall be placed according to the earth embankment requirements of OPSS 206 and compacted to a minimum 90% of its maximum dry density measured according to OPSS 501.

When the granular blanket is placed under water, it shall be placed by end dumping.

220.07.04 Trial Wick Drains

Prior to the installation of wick drains within the areas designated in the Contract Documents, it shall be demonstrated that the proposed materials, equipment, and installation method produce a satisfactory wick drain installation in accordance with these specifications. A minimum of 10 trial wick drains shall be installed at permanent installation locations designated by the Contract Administrator.

Provided the trial wick drains are installed to the satisfaction of the Contract Administrator, they shall be incorporated as part of the permanent installation.

The Contractor's Engineer shall monitor the trial wick drain installation on a full-time basis. If at any time the Contractor's Engineer considers that the method of installation does not produce a wick drain that satisfies the Contract requirements, the method or equipment or both, as necessary, shall be altered to comply with the requirements of the Contract Documents.

220.07.05 Installation

220.07.05.01 General

Wick drains shall be installed to the depths specified in the Contract Documents.

Wick drains shall be installed using a mandrel advanced through the granular blanket and the underlying soil. The mandrel shall protect the wick drain material from damage during installation and shall be withdrawn after the installation of the wick drain. The mandrel shall be provided with an anchor plate to prevent soil from entering the bottom of the mandrel during installation and to anchor the bottom of the wick drain at the required depth at the time of mandrel removal. The projected cross-sectional area of the mandrel and anchor combination shall not exceed 12,000 mm^2.

Augering or vibratory equipment may be used within the granular blanket and underlying soils to facilitate the installation of wick drains. The use of augering or vibratory equipment shall not extend more than 1 m into the soil to be consolidated.

220.07.05.02 Layout

Wick drains shall be located and staked out. The spacing of the wick drains shall not vary more than 150 mm from the spacing specified in the Contract Documents.

220.07.05.03 Vertical Alignment and Depth

Wick drains shall be installed with the mandrel vertically aligned having a tolerance of 1H:50V prior to driving. A suitable method of verifying the depth of the wick drain shall be maintained at all times.

220.07.05.04 Splices

Splices in the wick drain shall be made so as to ensure continuity and to prevent reduction in the wick drain discharge capacity. Splices shall be a minimum of 150 mm in length.

220.07.05.05 Cut-Off

The wick drain shall be cut at the surface of the granular blanket so that at least a 150 mm length protrudes above the top of the granular blanket at each wick drain location.

220.07.05.06 Obstructions

Where obstructions are encountered below the working surface that cannot be penetrated by the wick drain installation equipment, the wick drain shall be completed from the elevation of the obstruction to the working surface and the Contract Administrator shall be notified. At the direction of the Contract Administrator, an additional attempt to install a new wick drain within a 500 mm radius of the obstructed wick drain shall be performed. A maximum of two attempts shall be made as directed by the Contract Administrator.

220.07.06 Inspection after Wick Drain Installation

A Certificate of Conformance shall be submitted to the Contract Administrator upon completion of the wick drain installation and prior to the placement of any overlying material.

220.07.07 Management of Excess Material

Management of excess material shall be as specified in the Contract Documents.

220.08 QUALITY ASSURANCE

220.08.01 Manufacturer's Certificate

Certificates for each production lot indicating that the wick drain supplied was produced and tested according to the requirements of this specification shall be provided by the manufacturer for all wick drains delivered to the Contract.

220.08.02 Rejected Drains

Wick drains that are damaged or that do not meet the requirements of this specification shall be rejected and replaced. Replacement wick drains shall be installed within a 500 mm radius from the location of the rejected wick drain, as directed by the Contract Administrator.

220.09 MEASUREMENT FOR PAYMENT

220.09.01 Actual Measurement

220.09.01.01 Wick Drains

Measurement shall be by length in metres for all accepted wick drains, including the protruding portion up to 150 mm per installation.

Properly installed obstructed wick drains and replacement wick drains shall be measured for payment.

220.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

220.10 BASIS OF PAYMENT

220.10.01 Wick Drains - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

All labour, Equipment, and Material required for the granular blanket shall be paid for with the appropriate road base or subbase item, Granular B Type I, Granular B Type II, Granular B Type III, as specified.

TABLE 1
Wick Drain Property Requirements

Component	Property		Test Method	Unit	Requirement
Core	Physical	Material	--	--	Polypropylene, Studded or Grooved
		Thickness	ASTM D5199	mm	≥ 2
		Mass	ASTM D3776	g/m	≥ 40
	Mechanical	Tensile Strength	ASTM D638	N	≥ 800
Geotextile	Physical	Material	--	--	Polypropylene, Non-Woven
		Mass	ASTM D5261	g/m^2	≥ 110
	Mechanical	Grab Tensile Strength	ASTM D4632	N	≥ 600
		Puncture Strength	ASTM D6241	N	≥ 1375
		Trapezoidal Tear	ASTM D4533	N	≥ 250
		Filtration Opening Size (FOS)	CGSB 148.1, Method No. 10	µm	≥ 40
		Permittivity	ASTM D4491	s^{-1}	≥ 0.5
Composite Wick Drain	Physical	Width	--	mm	≥ 100
		Thickness	ASTM D5199	mm	≥ 3
	Mechanical	Discharge Capacity @ 10 kPa	ASTM D4716	m^3/s	≥ 1.2×10^{-4}
		Discharge Capacity @ 240 kPa	ASTM D4716	m^3/s	≥ 1.0×10^{-4}

CERTIFICATE OF CONFORMANCE

Contract Number: ……

Contractor: ……..……

Location / Structure: ……..……..……

Work, Component(s)/Element, or Product: ……...……

……..

……..……

I, _____ (print name), P. Eng. _____ (Professional Engineers of Ontario License Number) certify that the above-noted part of work, component, or product have been constructed in conformance to the requirements of the Contract Documents.

Seal and Signature

Date_____

DISTRIBUTION: 1) Contractor
2) Contract Administrator or Project Manager File

OPSF 539-1 (March 2021)

Appendix 220-A, April 2022
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Requirements for excavation and backfill of unsuitable material. (220.07.03)

- Limits and grade of the granular blanket. (220.07.03)

- Location of wick drains. (220.07.04)

- Depth of installation of wick drains. (220.07.05.01)

- Location and spacing requirements for wick drains. (220.07.05.02)

- Ensure granular blanket shall be paid for with the appropriate road base or subbase item. (220.10.01)

When there is significant variance in embedment depth, the designer should consider having more than one pay item based on depth.

Clause 220.07.06 requires the use of a Certificate of Conformance as shown on form OPSF 539-1. If a form other than OPSF 539-1 is to be used for submission purposes, the alternate form should be invoked by reference in the Contract Documents and the specification should be amended to remove reference to OPSF 539-1.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

CONSTRUCTION SPECIFICATION FOR RESTORING UNPAVED ROADWAY SURFACES

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301.08 **QUALITY ASSURANCE - Not Used**

301.09 **MEASUREMENT FOR PAYMENT**

301.10 **BASIS OF PAYMENT**

APPENDICES

301-A **Commentary**

301.01 SCOPE

This specification covers the requirements for the restoration of unpaved roadway surfaces to the required cross-section, profile, and density in preparation for its subsequent cover with a granular or surfacing course.

301.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be as specified in the Contract Documents.

301.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

301.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 314	Untreated Granular, Subbase, Base, Surface Shoulder, and Stockpiling
OPSS 501	Compacting
OPSS 506	Dust Suppressants

301.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Restored Surface means unpaved roadway surfaces prepared to the required grades and density and ready for a subsequent cover of granular or surfacing courses.

Scarification means uniform loosening of the roadway surface to remove damaged areas such as ravelling and potholes.

Surfacing Course means any bearing or wearing course or courses placed on the roadway and consisting of hot mix asphalt (HMA), Portland cement concrete, bituminous cold mix, and surface treatment.

Unpaved Roadway Surface means surfaces that are typically existing granular, but may include sub-grade soil surfaces.

301.07 CONSTRUCTION

301.07.01 Dust Suppressants

Dust suppressants shall be according to OPSS 506.

301.07.02 Method

Restoring roadway surfaces shall consist of the following:

a) The scarification of the existing surface specified in the Contract Documents to a depth not less than 75 mm but sufficient to remove potholes.

b) Restoring or reshaping the scarified material.

c) Compacting of the scarified materials according to OPSS 501.

d) Ensuring that the finished surface is within tolerance by checking the accuracy as specified in the Contract Documents.

The Contractor is responsible to maintain the scarified surface to the profile, cross-section, and density specified in the Contract Documents until the project is accepted or, if applicable, until any subsequent granular or surfacing course is completed.

Prior to scarification, roadway surfaces not more than 150 mm above grade shall be loosened and the materials removed to grade.

Unsuitable material encountered during restoring operations shall be removed to a depth not greater than 150 mm and replaced by acceptable granular material.

Materials loosened from the roadway surface and reshaped or incorporated during the restoring operation shall not require loading, hauling, or moving other than by blading.

301.07.03 Surface Tolerances

The surface of the unpaved roadway shall be restored to the specified tolerances for the following types of surfacing courses.

301.07.03.01 Granular Courses

The restored surface shall not deviate more than the following:

a) 30 mm from the specified grade and cross-section.

b) 30 mm at any place as measured in any direction with a 3 m straight edge when the work is to prepare the subgrade for granular courses.

c) 15 mm at any place as measured in any direction with a 3 m straight edge when the work is to prepare the granular surface for granular courses.

301.07.03.02 Bituminous Courses

The restored surface shall not deviate more than the following:

a) 30 mm from the specified grade and cross-section.

b) 30 mm at any place as measured in any direction with a 3 m straight edge when the work is to prepare the subgrade to receive full depth HMA.

c) 10 mm at any place as measured in any direction with a 3 m straight edge when the work is to prepare the granular surface to receive HMA.

301.07.03.03 Portland Cement Concrete Courses

The restored surface shall not deviate more than the following:

a) 10 mm from the specified grade and cross-section.

b) 10 mm at any place as measured in any direction with a 3 m straight edge when the work is to prepare a granular surface to receive concrete pavement or concrete base.

301.07.04 Surface Widths

The restored surface width shall be as specified in the Contract Documents.

301.07.05 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

301.09 MEASUREMENT FOR PAYMENT

301.09.01 Actual Measurement

301.09.01.01 Restoring Roadway Surfaces

Measurement of restored roadway surfaces shall be by area in square metres.

301.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

301.10 BASIS OF PAYMENT

301.10.01 Restoring Roadway Surfaces - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

301.10.02 Water

Payment for water for compaction shall be according to OPSS 501 and payment for water for dust suppression shall be according to OPSS 506.

301.10.03 Additional Materials

Payment for additional materials shall be according to OPSS 314.

Appendix 301-A, November 2018
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- The location, profile, and cross-section of the surfaces to be restored. (301.07.02)

- The density of materials used to restore roadway surfaces. (301.07.02)

- Accuracy of finished surface. (301.07.02)

- The surface width of restored surface. (301.07.04)

The designer may consider the following when determining surfaces to restore: (301.07.04)

- The width of the granular course when the work is to prepare the sub-grade or base for granular courses.

- The width of the proposed pavement plus 0.5 m on each side when the work is to prepare a granular road surface to receive the surfacing course.

- The full width of the earth surface when the work is to prepare the earth surface to receive a full depth hot mix asphalt.

- The width of proposed subsequent lanes against initial concrete base or pavement plus 0.5 m.

The designer may consider a geotechnical investigation to identify the existing conditions.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

CONSTRUCTION SPECIFICATION FOR PRIMING GRANULAR BASE

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302.09 **MEASUREMENT FOR PAYMENT**

302.10 **BASIS OF PAYMENT**

APPENDICES

302-A **Commentary**

302.01 SCOPE

This specification covers the requirements for surface preparation and application of bituminous primer on a granular base and placement of a sand cover to accommodate traffic.

302.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be as specified in the Contract Documents.

302.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

302.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 304 Single and Double Surface Treatment

Ontario Provincial Standard Specifications, Material

OPSS 1006 Aggregates - Surface Treatment
OPSS 1102 Liquid Asphalt
OPSS 1103 Emulsified Asphalt

Ministry of Transportation Publications

MTO Laboratory Testing Manual

Ontario Traffic Manual (OTM):
Book 7 - Temporary Conditions

302.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Appurtenances mean maintenance hole, catch basin, valve chamber, and water valve covers and similar Utility access covers located within the pavement portion of the roadway.

Lot means the quantity of work completed with a tanker truck shipment of primer.

Primer means the emulsified asphalt or low viscosity liquid asphalt sprayed on a prepared granular base.

Sand Cover means an aggregate applied over the primer to blot the primer and permit the passage of traffic.

302.05 MATERIALS

302.05.01 Primer

Primer shall consist of one or more of the following types of asphaltic materials:

a) Emulsified Asphalt Primer according to OPSS 1103.

b) MTO Primer or RC-30 according to OPSS 1102.

302.05.02 Sand Cover Aggregate

Aggregate shall be a Class 4 aggregate according to OPSS 1006.

302.06 EQUIPMENT

302.06.01 Pressure Distributor

The pressure distributor shall be designed and manufactured to spray primer uniformly on the road surface. The pressure distributor shall be capable of applying primer at the specified rates and in a continuous and uniform manner both longitudinally and transversely for a full lane width.

302.06.02 Mechanical Aggregate Spreader

The mechanical aggregate spreader shall be designed and manufactured to be self-propelled and capable of continuously and uniformly distributing aggregate on the primed granular base at the specified application rate.

302.06.03 Pilot Vehicle

The pilot vehicle shall be equipped according to the requirements of the OTM, Book 7.

302.06.04 Rollers

Rollers shall be according to OPSS 304.

302.07 CONSTRUCTION

302.07.01 Operational Constraints

Primer shall not be applied when the ambient temperature at the work location is less than 10 °C or when climatic conditions preclude the curing of the primer.

Primer shall not be applied prior to May 15th south of a line through Pembroke, Magnetawan, and Pointe au Baril Station and not prior to June 1st north of the line.

Emulsified primers shall not be applied after September 1st except with the approval of the Contract Administrator. .

The placing of aggregate shall be terminated one hour before sunset.

302.07.02 Sampling

302.07.02.01 Primer

The Contractor shall provide primer field samples for quality assurance (QA) testing purposes when specified in the Contract Documents.

The work shall include sampling, labelling, packaging, and delivery of samples to the laboratory designated in the Contract Documents within 5 Business Days.

Each liquid asphalt primer sample shall consist of a one-litre quantity of material. The sample containers for liquid asphalt primer samples shall be new epoxy-lined triple tight cans.

Each emulsified asphalt primer sample shall consist of 2 four-litre quantity of material. The sample containers for emulsified asphalt primer samples shall be new triple tight cans.

Sample containers shall be supplied by the Contractor. Sample labels supplied by the Contract Administrator shall be used to identify all samples.

302.07.02.02 Sand Cover Aggregate

The Contractor shall provide sand cover aggregate samples for QA testing purposes when specified in the Contract Documents.

302.07.03 Demonstration of Primer and Aggregate Application Rates

The Contractor shall demonstrate to the Contract Administrator satisfactory compliance to the specified application rates of primer and aggregate. At the Contract Administrator's option, this compliance may include a minimum 300 m length, one lane width trial section to ensure that the primer and aggregate are applied at the specified rate.

302.07.04 Longitudinal and Transverse Joints

Joints shall be constructed so that granular base is fully covered with primer and the overlap of primer and sand cover is minimal.

302.07.05 Protection of the Work

Traffic shall not be allowed on the primed granular base until the sand cover has been applied. Primed surfaces damaged by traffic shall be repaired by the Contractor.

302.07.06 Surface Preparation

The surface shall be free of standing water. The surface shall be prepared by dampening, fine grading, and compacting and finished rolled using a steel-drum roller to ensure a compacted smooth and float free surface immediately prior to the application of primer.

302.07.07 Application of Primer

Primer application temperatures shall be according to OPSS 1102 and OPSS 1103.

After the surface has been prepared, the primer shall be uniformly sprayed on the granular base at the rate specified in the Contract Documents.

The application of primer shall terminate at the same station for both lanes at the end of each day.

All roadway appurtenances within the area to be surfaced shall be properly covered and protected immediately prior to priming.

302.07.08 Application of Sand Cover

When specified in the Contract Documents, a sand cover shall be applied following the application of primer. A minimum curing time of 20 minutes for the primer shall be provided before sand cover aggregate is applied. Sand cover aggregate shall be uniformly applied by means of a mechanical aggregate spreader at the rate of 11 ± 1.0 kg/m^2.

Two passes of a pneumatic-tired roller shall be used to seat the aggregate.

302.07.09 Traffic Convoy

When specified in the Contract Documents, the Contractor shall convoy traffic according to OTM, Book 7.

The pilot vehicle shall guide one-way traffic through or around construction. The maximum speed of the convoy shall be 30 km/h. Convoys shall be maintained for a minimum of one hour after application of the sand cover, or longer, if directed by the Contract Administrator.

302.07.10 Management of Excess Material

Management of excess material shall be as specified in the Contract Documents.

302.08 QUALITY ASSURANCE

When specified in the Contract Documents, testing of the primer shall be conducted by the Contract Administrator, using current LS test methods of the MTO Laboratory Testing Manual or ASTM test procedures as required by OPSS 1102 or 1103.

302.09 MEASUREMENT FOR PAYMENT

302.09.01 Actual Measurement

302.09.01.01 Primer

Primer shall be measured by mass in kilograms as specified in the Contract Documents.

302.09.01.02 Sand Cover Aggregate

Measurement of sand cover shall be by mass or volume as specified in the Contract Documents.

302.09.01.02.01 By Mass

Sand cover aggregate applied to the road shall be measured by mass in tonnes as specified in the Contract Documents.

302.09.01.02.02 By Volume

Sand cover aggregate applied to the road shall be measured by volume in cubic metres, loose, by pre-determined truck capacities. The pre-determined capacity of each truck shall be that computed from its box dimensions.

Loading of each truck shall be to full pre-determined capacity. The Contractor shall not be required to load trucks in excess of this capacity to allow for bulking, and no deduction shall be made for any settlement of the load during transportation, provided that such settlement is not caused by spillage or leakage.

Each truck shall be uniquely and readily identifiable.

302.09.01.03 Traffic Convoy

The measurement for traffic convoy shall be in hours based on the number of hours that the pilot vehicle is convoying traffic.

302.10 BASIS OF PAYMENT

302.10.01 Primer - Item
Sand Cover Aggregate - Item
Traffic Convoy - Item

Payment at the Contract price for the above items shall be full compensation for all labour, Equipment, and Material to do the work.

Primed surfaces damaged by traffic shall be repaired at no cost to the Owner.

Appendix 302-A, Commentary for OPSS.MUNI 302, November 2016
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Rate of application of primer. (302.07.07)

The designer should determine if the following is required and, if so, specify it in the Contract Documents:

- Frequency and type of QA testing required. (302.07.02.01 an302.07.02.02)
- Location of laboratory for delivery of samples. (302.07.02.01)
- Sand cover. (302.07.08)
- Traffic convoy requirements. (302.07.09)
- Testing of the primer. (302.08)
- Measurement for payment of sand cover aggregate by mass or volume. (302.09.01.02)

Priming of the granular base is required for the application of single surface treatment or one lift of hot mix asphalt.

Sand cover is required when traffic travels on the primed granular base prior to placement of a surface.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here

CONSTRUCTION SPECIFICATION FOR DOUBLE CHIP SEAL

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303-A **Commentary**

303.01 SCOPE

This specification covers the requirements for the use of double chip seal.

303.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be as specified in the Contract Documents.

303.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

303.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Material

OPSS 1006	Aggregates - Surface Treatment
OPSS 1103	Emulsified Asphalt

Ontario Ministry of Transportation Publications

MTO Laboratory Testing Manual:

LS-601	Material Finer than 75 μm Sieve in Mineral Aggregates by Washing
LS-602	Sieve Analysis of Aggregates

Ontario Traffic Manual (OTM):

Book 7	Temporary Conditions
SP-021	Manual for the Condition Rating of Surface Treated Pavement

European Standards (EN)

EN12272-3:2003	Determination of Binder Aggregate Adhesivity by the Vialit Plate Shock Test Method

303.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Appurtenances mean maintenance hole, catch basin, valve chamber, and water valve covers and similar Utility access covers located within the paved portion of the roadway.

Double Chip Seal means two successive single chip seals with different aggregate gradations.

Median Size of Aggregate means the aggregate size that is determined by a standard plot of the gradation of the aggregate, using all standard sieve sizes, and then graphically determining the median size, which is the size in mm corresponding to per cent finer than 50%.

Single Chip Seal means a single application of bituminous binder followed by a single application of uniformly graded aggregate.

Single Sized Aggregate means a uniformly graded aggregate with at least two-thirds, by weight, passing through a sieve of the specified size and retained on a sieve no less than 70% of the specified size, when tested according to LS-602. The specified size shall vary according to the design of the chip seal application.

303.04 DESIGN AND SUBMISSION REQUIREMENTS

303.04.01 Design Requirements

To ensure satisfactory performance on the roadway according to the traffic, pavement, and geometric roadway data specified in the Contract Documents, using a recognized chip seal design methodology, a laboratory equipped and staffed to carry out chip seal design shall designate the type and grade of asphalt binder, the class of aggregate, and their application rates.

The laboratory designing the chip seal shall confirm the compatibility for the first application of the asphalt binder and the aggregate used in the chip seal by performing the mechanical adhesivity test as per EN12272-3 and meeting the requirements as specified in the Compatibility of Asphalt binder and Aggregate subsection.

All component materials used in the chip seal design shall be representative of the material proposed by the Contractor for use on the Contract.

Chip seal shall only be placed after the Contract Administrator has issued confirmation in writing within 5 Business Days that the chip seal design has been reviewed and meets the specified requirements.

303.04.01.01 Laboratory Requirements

303.04.01.01.01 General

Equivalent alternate laboratory and technician certifications or laboratory proficiency sample testing programs may be used to demonstrate similar requirements to those specified below provided they are acceptable to the Owner.

303.04.01.01.02 Aggregates

An acceptable laboratory conducting tests for physical properties or consensus properties shall be one that holds a certificate from the Canadian Council of Independent Laboratories (CCIL) as Type D for the applicable test methods and also participates in the annual MTO Proficiency Sample Testing Program.

An acceptable laboratory conducting tests for LS-601 and LS-602 shall be one that holds a valid certificate from CCIL as Type C. Testing for LS-601 and LS-602 shall be conducted by qualified laboratory staff who hold a valid certificate from CCIL in aggregate testing.

303.04.01.01.03 Asphalt Binder

An acceptable laboratory for conducting the tests to ensure the binder meets the requirements of OPSS 1103 shall be an accredited laboratory in Ontario's inter-laboratory correlation program. An accredited laboratory shall be one that maintains a satisfactory rating from the MTO Emulsion Correlation Program.

303.04.01.01.04 Asphalt Binder and Aggregate Compatibility Testing

An acceptable laboratory for conducting a test EN12272-3 shall be one that holds a valid certificate from CCIL as Type A or a laboratory that maintains a satisfactory rating from the MTO Emulsion Correlation Program.

303.04.02 Submission Requirements

303.04.02.01 Chip Seal Design

Ten Business Days prior to the start of the placing of the chip seal, the chip seal design shall be submitted in writing to the Contract Administrator together with supporting test results showing conformance of the asphalt binder and aggregates with the requirements of the Contract Documents. For test EN12272-3, a written report on the test method and the results, including a photographic record, shall be provided.

Prior to making the submission, an Engineer's seal and signature shall be affixed on the chip seal design verifying that the chip seal design is consistent with the requirements of the Contract Documents.

Test data must be legible and signed by the testing laboratory representative.

Representative samples of the materials to be used in the work shall be provided with the chip seal design.

303.04.02.01.01 Material Samples

Samples shall be labelled with the following information:

a) Contract number.

b) Material type.

c) Material source.

d) Date sampled (i.e., yyyy-mm-dd).

e) Sample location.

Each material sample shall be packaged separately and the samples shall be in containers that are clean, closed, and rupture proof, when lifted or handled. Each filled sample container shall have a maximum mass of 30 kg.

The minimum emulsified asphalt sample quantity shall be 4 litres evenly split between 2 containers.

Aggregate sample quantities shall be a minimum of 25 kg of each aggregate.

Samples for all other materials to be used in the chip seal applications shall be provided in quantities large enough to allow confirmation of the design.

303.04.02.02 Calibration Records for Distributors and Aggregate Spreaders

Prior to the start of the work of chip sealing, calibration records shall be submitted, in writing, to the Contract Administrator.

303.05 MATERIALS

303.05.01 Asphalt Binder

The asphalt binder shall be a rapid setting polymer modified emulsified asphalt according to OPSS 1103.

303.05.02 Aggregates

303.05.02.01 General

Aggregates for both applications of chip seal shall be of the same geological parent produced from the same source.

Aggregates shall be obtained from a source listed on the MTO's Designated Sources List for coarse aggregates for HL 1 or Superpave 12.5 FC1 hot mix.

In areas north of North Bay, where FC1 aggregates may not be available, the aggregates shall meet the physical requirements of OPSS 1006.

Aggregates containing slag are not permitted for use in a chip seal application.

303.05.02.02 Physical Requirements

The physical requirements of the aggregates for the first application of chip seal shall be according to those of a Class I aggregate according to OPSS 1006.

303.05.02.03 Gradation Requirements

303.05.02.03.01 First Application

Aggregate for the first application of chip seal shall be single sized aggregate determined by the chip seal design with the following additional requirements:

a) The aggregate shall be no finer than the gradation of a Class 1 aggregate according to OPSS 1006.

b) The maximum median size shall be 13.6 mm.

303.05.02.03.02 Second Application

The gradation requirements of the aggregate for the second application of chip seal shall be determined by the chip seal design with the following requirements:

a) The gradation of the aggregate shall be 100% passing the 9.5 mm sieve and a maximum 1% passing the 75 µm sieve.

b) The median size of the aggregate shall be 40 to 55% of the median size of the aggregates used in the first application.

303.05.03 Compatibility of Asphalt Binder and Aggregate

Adhesivity values or % aggregate retentions of the selected binder-aggregate combination determined by the mechanical adhesivity test in EN12272-3 shall be minimum 90%.

303.06 EQUIPMENT

303.06.01 Pilot Vehicle

The pilot vehicle shall be equipped according to the requirements of the OTM, Book 7.

303.07 CONSTRUCTION

303.07.01 Operational Constraints

Public traffic shall only be permitted to travel on the final compacted surface of the second application of chip seal.

The work shall not be carried out when the ambient temperature is less than 10 °C or when climatic or site conditions preclude the curing of the binder.

The application of binder and aggregate shall terminate 1 hour before sunset.

Chip sealing shall not be carried out prior to May 15th south of a line drawn through Pembroke, Magnetawan, and Pointe au Baril Station or prior to June 1st north of the line.

After September 1st, written approval shall be obtained from the Contract Administrator prior to chip sealing.

303.07.02 Calibration of Distributors and Aggregate Spreaders

Within 14 Days before the start of the work of chip sealing, all distributors and aggregate spreaders to be used in the work shall be calibrated using a recognized calibration method.

303.07.03 Traffic Convoy

The Contractor shall convoy traffic according to the OTM, Book 7.

The pilot vehicle shall guide one-way traffic through or around construction. The maximum speed of the convoy shall be 30 km/h.

Convoying shall be maintained until such time as the chip seal is able to carry traffic without damage.

303.07.04 Quality Control

The Contractor shall conduct such quality control procedures, including sampling and testing, as is necessary to ensure that all aggregates and all asphalt binder to be used in the work conform to the requirements of the Contract.

Upon request of the Contract Administrator, the Contractor shall supply copies of any or all test results.

303.07.05 Surface Preparation

The area to receive chip seal shall be thoroughly cleaned using a rotary power broom to remove all sand, dirt, and other debris. Areas inaccessible to a rotary power broom shall be manually cleaned.

All roadway appurtenances within the chip seal area shall be properly covered and protected immediately prior to chip sealing.

303.07.06 Chip Seal Application

A double application of asphalt binder and aggregate shall be placed according to the Contract Documents in the location and to the length and width requirements specified in the Contract Documents.

303.07.07 Joints

Longitudinal joints shall be placed on lane lines.

Longitudinal joints, on the second application, shall have an overlap of 50 to 100 mm.

303.07.08 Appearance

The longitudinal and transverse joints shall be neat and uniform in appearance, with no excessive build-up, uncovered areas, or unsightly appearance.

The chip seal edge shall be neat and uniform along the roadway lane, shoulder, and curb lines.

303.07.09 Clean-up

Areas not to receive chip seal shall have the chip seal material removed immediately.

Appurtenances shall be free of chip seal and left in an operable condition.

303.07.10 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

303.08 QUALITY ASSURANCE

303.08.01 Sampling and Testing

The Contract Administrator reserves the right to request samples of field asphalt binder and aggregate for quality assurance testing purposes. Material samples shall be according to the Material Samples clause.

303.08.02 Initial Acceptance

At the completion of the chip sealing operations, the completed surface course shall not have distresses with higher severity than slight flushing, slight streaking, or slight loss of cover aggregate, including delamination, as described by SP-021.

303.08.03 Warranty Requirements

303.08.03.01 Warranty Period

The Warranty Period shall be 24 months.

303.08.03.02 Warranty Repairs

The Owner shall inform the Contractor in writing any time within the first 23 months of the Warranty Period of surface defects requiring repair.

In addition, a survey of surface defects shall be completed by the Owner at the end of 1 year and a second survey of surface defects a minimum of 45 Days prior to the end of the Warranty Period. The results of both surveys shall be sent to the Contractor.

The types of surface defects, their severity, their density or extent, and the exact dimensions of the warranty repairs shall be determined by the Owner and recorded according to Table 1.

If the Owner determines that the surface defects pose a hazard to the travelling public at any time during the Warranty Period, the Contractor shall make the repairs in accordance with this specification within 14 Days of being notified. In all other cases, repairs shall be completed no later than 14 Days prior to the warranty expiration date.

Repairs shall be made according to Table 1.

The length of a repair shall be sufficient to eliminate all surficial defects as described.

The width of a repair area shall not be less than one lane width unless approved by the Owner

Materials used in the repair area shall be consistent with those originally used on the Contract. The use of alternate aggregates meeting the aggregate requirements of the Aggregates subsection may be used in the repair area with the approval of the Owner.

Repairs shall be to the approval of the Owner.

Repair areas shall not have transverse or longitudinal ripples of 6 mm or more as measured with a 3 m straight edge.

303.08.04 Completion of Warranty Period

At the end of the Warranty Period, the work shall meet the provisions of the Performance Requirements subsection in order for the Contractor to be released from responsibility and ensure return of the performance bond or letter of credit or certified cheque.

303.08.05 Performance Requirements

The chip seal shall be free from any:

a) Aggregate loss that is moderate to severe.

b) Flushing that is moderate to severe.

c) Streaking that is moderate to severe.

Shaving of the chip seal surface during snow-plough operations (snow-plough damage) is exempt from the Performance Requirements and Warranty Requirements.

303.09 MEASUREMENT FOR PAYMENT

303.09.01 Actual Measurement

303.09.01.01 Double Chip Seal

Measurement of the chip seal placed shall be by area in square metres.

303.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

303.10 BASIS OF PAYMENT

303.10.01 Double Chip Seal - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

Repair, removal, disposal, and replacement of any damaged or defective chip seal shall be at no extra cost to the Owner.

TABLE 1
Chip Seal Repair

Surface Defect	Severity	Density or Extent per 100 m of lane length	Required Repair
Loss of Cover Aggregate	Slight	Intermittent, frequent, or extensive	No action required.
	Moderate or Severe	Intermittent or frequent	Single chip seal with top aggregate of the affected area applied manually or by machine.
	Moderate or Severe	Extensive (Note 1)	Double chip seal of the affected area.
Flushing	Slight	Intermittent, frequent, or extensive	No action required.
	Moderate	Intermittent (Note 2) Frequent or extensive (Note 1)	Single chip seal with top aggregate of the affected area.
	Severe	Intermittent (Note 2) Frequent or extensive (Note 1)	Remove and replace the double chip seal of the affected area.
Streaking	Slight	Intermittent, frequent, or extensive	No action required.
	Moderate	Intermittent (Note 2) Frequent or extensive (Note 1)	Single chip seal with top aggregate of the affected area.
	Severe	Intermittent (Note 2) Frequent or extensive (Note 1)	Sand seal followed by double chip seal of the affected area.

Notes:

1. Area of the repair or replacement shall not be less than one lane width x 50 m in length.

2. Area of the repair or replacement shall not be less than one lane width x 10 m in length. If there is less than 10 m between 2 sections in the lane designated for repair or replacement, the repair or replacement shall be continuous.

A. Descriptions of surface defects and severity are according to SP-021.

Appendix 303-A, November 2018
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

Chip seal is a preventive maintenance or holding strategy used to preserve and extend the life of an existing road surface.

The designer should specify the following in the Contract Documents:

- Traffic data (e.g., AADT, % Commercial traffic, and intersections with heavy commercial traffic turning movements). (303.04.01)

- Pavement data (e.g., existing pavement type, type of treatment applied to the existing pavement and the year of application, and conditions and problems with the existing pavement (e.g., occurrences of flushing). (303.04.01)

- Geometric data (e.g., maximum grade). (303.04.01)

- Location, length, and width requirements of area to receive chip seal. (303.07.06)

To achieve pavement preservation benefits, chip seal must be carried out when the level of pavement distress is low.

Significant deficiencies in the pavement surface (i.e., deformations, rutting, cracks, potholes, subgrade failures, drainage, and excess asphalt on patches and joints) should be repaired before applying chip seal to the roadway.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

CONSTRUCTION SPECIFICATION FOR SINGLE AND DOUBLE SURFACE TREATMENT

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304-A **Commentary**

304.01 SCOPE

This specification covers the requirements for surface preparation, application of bituminous binder, and application of aggregate for single and double surface treatment.

304.01.01 Significance and Use of Appendices

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be as specified in the Contract Documents.

332.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

304.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Material

OPSS 1006 Aggregates - Surface Treatment
OPSS 1103 Emulsified Asphalt

Ministry of Transportation Publications

Ontario Traffic Manual (OTM):
Book 7 - Temporary Conditions

304.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Appurtenances mean maintenance hole, catch basin, valve chamber, and water valve covers and similar Utility access covers located within the paved portion on the roadway.

Binder means an emulsified asphalt with or without polymer modification used to bind aggregates.

Double Lap means the coverage produced from the application of binder where the binder from each spray bar nozzle overlaps the binder application from the adjacent nozzle by one half.

Double Surface Treatment means two successive single surface treatments.

End Nozzle means a spray bar nozzle which delivers binder to the inside half of a standard spray pattern.

Lot means the quantity of work completed with a tanker truck shipment of binder.

Single Surface Treatment means a single application of bituminous binder followed by a single application of Class 1, Class 2, Class 3, Class 4, Class 5, or Class 6 aggregate.

Triple Lap means the coverage produced from the application of binder where the binder from each spray bar nozzle overlaps the binder application from the adjacent nozzle by two thirds.

304.05 MATERIALS

304.05.01 Binders

Binders shall be according to OPSS 1103.

304.05.02 Aggregates

Aggregates shall be according to OPSS 1006 and as specified in the Contract Documents.

304.06 EQUIPMENT

304.06.01 Pressure Distributor

The pressure distributor shall be designed and manufactured to spray binder on the road surface. The pressure distributor shall be capable of applying binder at the specified rates and in a continuous and uniform manner both longitudinally and transversely for a full lane width.

304.06.02 Mechanical Aggregate Spreader

The mechanical aggregate spreader shall be designed and manufactured to be self-propelled and capable of continuously and uniformly distributing aggregate at the specified application rate.

304.06.03 Rotary Power Brooms

Brooms shall be capable of cleaning gravel, sand, dirt, and other debris from the roadway surface.

304.06.04 Rollers

304.06.04.01 General

Rollers shall be ballasted according to the manufacturer's recommendations.

304.06.04.02 Steel Drum Rollers

Steel drum rollers shall be single drum vibratory rollers according to Table 1 and shall be operated in the static mode, if the drum is not rubber coated. Drive wheels shall not mark the aggregate.

304.06.04.03 Pneumatic-Tired Rollers

Pneumatic-tired rollers shall be self-propelled and be according to Table 2. The wheels shall be mounted with smooth tread rubber tires. Tire inflation pressure shall be a minimum of 350 kPa when the tires are cold. All

tires shall have equal pressure. Each roller shall be equipped with a suitable tire pressure gauge for checking tire inflation pressure.

304.06.05 Pilot Vehicle

The pilot vehicle shall be equipped according to the requirements of the OTM, Book 7.

304.07 CONSTRUCTION

304.07.01 Operational Constraints

Surface treating operations shall not be carried out when the ambient temperature at the work location is less than 10 °C or where climatic or site conditions preclude the curing of the binder.

The application of binder and aggregate shall terminate one hour before sunset.

Surface treatment shall not be carried out prior to May 15th south of a line through Pembroke, Magnetawan, and Pointe au Baril Station or prior to June 1st north of the line.

Surface treatment shall not be carried out after September 1st except with the approval of the Contract Administrator. Surface treatment may be extended to September 30th provided a high float emulsion is used.

304.07.02 Sampling

304.07.02.01 Binder

The Contractor shall provide binder field samples for testing purposes as specified in the Contract Documents.

The work shall include sampling, labelling, packaging, and delivery of samples to the laboratory designated in the Contract Documents within 5 Business Days.

Each binder sample shall consist of a minimum size of two full 4-litre samples of material. The sample containers for emulsified asphalt binder samples shall be triple tight cans. Sample containers shall be new and supplied by the Contractor.

304.07.02.02 Aggregates

The Contractor shall provide aggregate samples for testing purposes as specified in the Contract Documents.

304.07.03 Determination of Binder and Aggregate Application Rates

The application rate for the binder and the aggregate shall be as specified in the Contract Documents.

The Contractor shall demonstrate to the Contract Administrator satisfactory compliance to the specified application rates of binder and aggregate. At the Contract Administrator's option, this compliance may include a minimum 300 m one lane width trial section to ensure that the binder and aggregate are applied at the specified rate.

304.07.03.01 Acceptance of Binder Application Rate

The binder application rate is acceptable when the rate of application is within a tolerance of ± 5% of the specified rate.

304.07.03.02 Acceptance of Aggregate Application Rate

The aggregate application rate is acceptable when the rate of aggregate application is within a tolerance of ± 10% of the specified rate.

304.07.04 Surface Preparation

Existing bituminous surfaces shall be clean and free of all debris and standing water before application of binder.

Where a binder is to be applied on a granular surface, the surface shall be free of standing water and shall be prepared by dampening, fine grading, and compacting immediately prior to the application of the binder. The surface shall be finish rolled to ensure a compacted smooth and float free surface.

304.07.05 Binder Application Temperatures

Binder application temperatures shall be according to OPSS 1103.

304.07.06 Application of Binder

After the surface has been prepared, the binder shall be uniformly sprayed on the road surface at the specified application rate. When binder is to be applied to two adjacent lanes, the application of binder on the initial pass shall be done without the use of an end nozzle. When binder is applied to the adjacent lane, the nozzle positioned closest to the first application of binder shall be an end nozzle.

The spray bar height shall be adjusted to ensure that there is triple lap of the binder application. At the written request of the Contractor, the Contract Administrator may allow the use of a double lap application.

Longitudinal joints shall be constructed to ensure full coverage on the centreline.

The application of binder shall terminate at the same station for both lanes at the end of each day.

All roadway appurtenances within the area to be surfaced shall be properly covered and protected immediately prior to single and double surface treatment.

304.07.07 Application of Aggregate

Aggregate shall be uniformly applied at the rate specified. The distance between the pressure distributor and the spreader shall not be more than 30 m.

If excess aggregate is present when constructing a double surface treatment, the excess shall be removed prior to the second application of binder.

304.07.08 Rolling

Immediately after spreading, the aggregate shall be rolled with a minimum of two pneumatic-tired rollers. The entire treated area shall receive two passes from each pneumatic-tired roller.

When the surface treatment is placed on a prepared granular grade, one pneumatic-tired roller shall be replaced by a steel drum roller. The entire treated area shall receive two passes from the pneumatic-tired roller and one pass from the steel drum roller.

Rollers shall be operated at such a speed as to prevent aggregate pick-up, but in no case shall the speed of rollers exceed 10 km/h.

All rolling shall be completed within 300 m of the aggregate spreader. When the combination of rollers is not sufficient to maintain the completed rate of progress, additional rollers shall be used.

304.07.09 Traffic Convoy

When specified in the Contract Documents, the Contractor shall convoy traffic according to the OTM, Book 7.

The pilot vehicle shall guide one-way traffic through or around construction. The maximum speed of the convoy shall be 30 km/h. Convoying shall be maintained until such time as the surface treatment is able to carry traffic without damage.

304.07.10 Protection of the Work

The Contractor shall repair damaged areas until such time as the work has been accepted by the Contract Administrator.

Signs indicating fresh surface treatment, or similar wording, shall be erected at the project limits and any intersections throughout the project immediately after placement of surface treatment and shall remain in place for a minimum of 72 hours.

304.07.11 Management of Excess Material

Management of excess material shall be as specified in the Contract Documents.

304.09 MEASUREMENT FOR PAYMENT

304.09.01 Actual Measurement

304.09.01.01 Binder

Binder shall be measured for payment by mass in kilograms according to the requirements of the Contract Documents.

304.09.01.02 Class 1, 2, 3, 4, 5 or 6 Aggregate

304.09.01.02.01 By Mass

Aggregate applied to the road shall be measured in tonnes according to the requirements of the Contract Documents.

304.09.01.02.02 By Volume

Measurement shall be by volume in cubic metres, loose, by predetermined truck capacities. The predetermined capacity of each truck shall be that computed from its box dimensions.

Loading of each truck shall be kept to not less than the predetermined capacity. The Contractor shall not be required to load trucks in excess of this capacity to allow for bulking, and no deduction shall be made for any settlement of the load during transportation, provided that such settlement is not caused by spillage or leakage.

Each truck shall be uniquely and readily identifiable.

304.09.01.03 Traffic Convoy

The measurement for traffic convoy shall be in hours based on the number of hours that the pilot vehicle is convoying traffic.

304.10 BASIS OF PAYMENT

304.10.01 Binder *"type"* - Item
Class 1 Aggregate - Item
Class 2 Aggregate - Item
Class 3 Aggregate - Item
Class 4 Aggregate - Item
Class 5 Aggregate - Item
Class 6 Aggregate - Item
Traffic Convoy - Item

Payment at the contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Damaged areas requiring repair prior to the acceptance of the work shall be repaired by the Contractor at no extra cost to the Owner.

TABLE 1
Requirements for Steel Drum Rollers

Minimum Drum Diameter mm	Minimum Drum Width mm	Minimum Static Mass per mm of Drum Width kg
1500	2100	2

TABLE 2
Requirements for Pneumatic-Tired Rollers

Roller Class	Minimum Mass t	Minimum Mass per Tire kg
R1	8	900
R2	18	2500
R3	25	3600

Appendix 304-A, Commentary for OPSS.MUNI 304, November 2016
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specifications in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Class of Aggregate required. (304.05.02.01)
- Frequency and type of QA testing required. (304.07.02)
- Location of laboratory for delivery of samples. (304.07.02.01)
- Application rate for the binder and aggregate. (304.07.03)
- Traffic convoy requirements. (304.07.09)

The following applications are available depending on traffic volumes, status of road, and type of road surface:

- Single surface treatment is typically applied to either a primed road, a roadway with a previously applied surface treatment, or a paved road.

- Double surface treatment is typically applied to either a granular base or a primed road.

For design estimating purposes, the following application rates may be used:

Treatment	Aggregate Type	Primer or Binder (Note 1)			Aggregate		
		Grade	Range kg/m^2	Typical kg/m^2	Class	Range kg/m^2	Typical kg/m^2
Prime	Class 4	Primer	1.90+/-	1.9	4	10-12	12
Single Surface Treatment	Class 1	CRS-2 or RS-2	1.65-1.90	1.8	1	14-17	16
	Class 2 (Notes 2, 6)	HF-150S	1.35-1.55	1.45	2	16.5-19	19
	Class 4 (Note 3)	CRS-2,HF-150S	1.20-1.40	1.3	4	8-11	11
	Class 5	CRS-2 or RS-2	1.15-1.45	1.3	5	11-13	13
	Class 6	HFMS-2(ON) or HFMS-2P(ON)	1.50-1.80	1.7	6	16-20	17
Double Surface Treatment	Class 2, Note 6	HF-150S (Note 4)	1.60-1.80	1.65	2	16-18	18
		HF-150S (Note 5)	1.45-1.65	1.5	2	16.5-19	19
	Class 3 & 1	CRS-2,RS-2 (Note 4)	1.60-2.10	1.9	3	15-18	17
		CRS-2,RS-2 (Note 5)	1.40-2.10	1.8	1	12-15	14
	Class 3 & 4	CRS-2,RS-2 (Note 4)	1.60-1.75	1.65	3	15-18	17
		CRS-2,RS-2 (Note 6)	1.05-1.20	1.1	4	6.5-8	8
	Class 3 & 5	CRS-2,RS-2 (Note 4)	1.80-2.00	1.90	3	15-17	17
		CRS-2,RS-2 (Note 5)	1.30-1.50	1.35	5	11-13.5	13
	Class 2 & 6	HFMS-2P(ON) (Note 4)	1.60-1.80	1.65	2	13.5-18	16
		HFMS-2P(ON) (Note 5)	1.50-1.70	1.60	6	15-19	16

Notes:

1. Decrease binder rates towards the lower limit of the range when there is heavy commercial traffic.
2. Class 2 surface treatment may cause dust problems in urban areas.
3. Do not apply to flushed surface treatments, flushed pavements or where low friction values are a concern.
4. Initial application.
5. Second application.
6. The use of Granular A aggregate in a Single or Double Surface Treatment is not recommended.

Appendix 304-A

If a granular grade is planned to be open to traffic for a considerable length of time prior to the surface treatment operation, the designer should consider including an item for surface restoration according to OPSS 301, Restoring Unpaved Roadway Surfaces.

The designer should ensure that the Ontario Provincial Standards General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here

CONSTRUCTION SPECIFICATION FOR GRANULAR SEALING

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305-A **Commentary**

305.01 SCOPE

This specification covers the materials and requirements for the work of surface preparation and the supply and application of sealer to granular shoulders, shoulder rounding, and all other designated areas.

305.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

305.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

305.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications

Ontario Provincial Standard Specifications, Construction

OPSS 304	Single and Double Surface Treatment
OPSS 501	Compacting

Ontario Provincial Standard Specifications, Materials

OPSS 1010	Aggregates – Base, Subbase, Select Subgrade, and Backfill Material
OPSS 1102	Liquid Asphalt
OPSS 1103	Emulsified Asphalt
OPSS 2510	Tall Oil Pitch Emulsion

Ontario Ministry of Transportation, Publications

MTO Laboratory Testing Manual:

LS-100	Rounding-Off of Test Data and Other Numbers
LS-200	Penetration of Bituminous Materials
LS-202	Method of Test for Kinematic Viscosity of Asphalts
LS-204	Solubility of Bituminous Materials in Trichloroethylene
LS-205	Ductility of Bituminous Materials
LS-216	Determination of Residue by Distillation of Emulsified Asphalts
LS-217	Determination of Oil Portion of Distillate in Emulsified Asphalt Primers
LS-218	Particle Charge of Emulsified Asphalt and Emulsified Asphalt Primers
LS-219	Viscosity of Emulsified Asphalts

LS-221 Settlement and Storage Stability of Emulsified Asphalt
LS-223 Sieve Test for Emulsified Asphalts

ASTM International

D1310-14 Standard Test Method for Flash Point and Fire Point of Liquids by Tag Open-Cup Apparatus

D402/D402M-14 Standard Test Method for Distillation of Cutback Asphalt

305.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Lot means a specific quantity of material or a specific amount of construction obtained from a single source and produced by the same process.

Quality Assurance means a system or series of activities carried out by the Owner to ensure that Materials received from the Contractor meet the requirements specified in the Contract Documents.

305.05 MATERIALS

Sealers may consist of one or more of the following materials:

a) Type I-a: RC-30 and MTO primer according to OPSS 1102; or
Type I-b: Emulsified asphalt primer according to OPSS 1103.

b) Type II: Solvent-free emulsified asphalt according to OPSS 1103.

c) Type III: Tall oil pitch (TOP) emulsion according to OPSS 2510.

305.06 EQUIPMENT

The pressure distribution system used for sealer application shall be according to OPSS 304 and, when applicable, shall include an attachment for hand spraying.

Rollers shall be steel-drum or pneumatic-tired according to OPSS 304.

305.07 CONSTRUCTION

305.07.01 Operational Constraints

A sealer shall only be applied when:

a) The ambient temperature is a minimum of 5 °C and rising.

b) The designated area to be sealed is not frozen.

c) Precipitation is not occurring or imminent and, for Type III emulsion applications, precipitation has not occurred within the 24 hours prior to application.

d) The surface is free of standing water.

e) The wind is not strong enough to cause drifting of sealer spray.

f) The shoulder is smooth and conforms to the crossfall and grade specified in the Contract Documents.

305.07.02 Surface Preparation

As soon as is practical prior to applying sealer, the granular shoulder shall be rolled with a minimum of two passes. The shoulder rounding surface shall not be rolled.

Granular materials to be sealed with Type I or Type II sealers shall be uniformly dampened immediately prior to applying.

The moisture content of granular materials to be sealed with a Type III sealer shall be according to the manufacturer's recommendations.

305.07.03 Application

The sealer types and the locations where they shall be used are specified elsewhere in the Contract Documents.

Type I-a or Type I-b sealers may be used in any areas where Type I sealers have been specified.

Sealers shall be uniformly applied in all areas using a pressure distribution system.

Sealer application rates and temperatures shall be as specified in Table 1.

Sealers shall be overlapped a minimum of 100 mm onto adjacent paved surfaces.

All other application requirements shall be in accordance with the Manufacturer’s recommendations and the application performed to the satisfaction of the Contract Administrator.

305.07.04 Management of Excess Material

Management of excess material shall be as specified in the Contract Documents.

305.08 QUALITY ASSURANCE

305.08.01 General

The Owner reserves the right to make inspections, take samples, and perform QA tests, at such times and locations as the Owner may consider necessary, in order to ensure that the materials supplied and placed are in accordance with this specification.

305.08.02 Sampling of Sealer for Acceptance

Sealers shall be randomly sampled in lots as specified in Table 2.

If the remaining quantity after completing a lot is less than one-half the quantity for a complete lot, then that quantity shall be added to the previous lot. Otherwise the remaining quantity shall form its own lot.

The Contract Administrator shall randomly-choose one sample of sealer from the designated truck tanker representing each lot.

Duplicate samples shall be taken from a sampling spigot on the transfer line or, if one is not available, from the end of the transfer line. Each sample shall be taken after sufficient material has been drawn from the truck tank to purge the transfer line. Sample containers shall be supplied and filled, leaving sufficient space to allow for expansion.

Sampling requirements shall be as specified below and elsewhere in the Contract Documents.

Sample containers for each portion of each duplicate sample shall be triple tight one-litre cans for Type I-a or Type III sealers or triple tight four-litre pails, or suitable plastic containers of similar capacity that can be closed to prevent any leakage for Type I-b or Type II sealers.

Identification tags, provided by the Contract Administrator, shall be completed and attached to each sample container. All sample containers shall be supplied with appropriate WHMIS labels.

Samples shall be delivered within the required time and to the appropriate laboratory specified by the Owner.

305.08.03 Sealer Quality

305.08.03.01 Acceptance

One portion of each duplicate sample shall be tested for material properties by the QA laboratory according to OPSS 1102 for Type I-a sealers, OPSS 1103 for Type I-b and Type II sealers, and OPSS 2510 for Type III granular sealers, respectively.

Individual test results shall be forwarded to the Contractor as they become available.

A lot of sealer shall be deemed to be acceptable, if all of the test results and other requirements specified in OPSS 1102 for Type I-a sealers, OPSS 1103 for Type I-b and Type II sealers, and OPSS 2510 for Type III granular sealers are respectively met.

A lot of sealer not meeting all of the sealer quality requirements shall be given a payment adjustment, as specified in the clause under Payment Adjustments for Sealers.

The Owner shall be responsible for all costs associated with QA testing for acceptance.

305.08.03.02 Referee Testing

The Contractor may invoke referee testing for one or more tested attributes by submitting a written request to the Contract Administrator, within 2 Business Days following notification that the sealer does not meet the requirements of this specification.

Referee testing shall be carried out as specified below and elsewhere in the Contract Documents.

All referee test results for any lot shall replace the respective QA tests for acceptance of the applicable lot and shall be binding on both the Owner and the Contractor.

If a lot is not accepted at full payment based on the referee test results, then the Contractor shall be responsible for the cost of the referee testing of that lot at the rates specified elsewhere in the Contract Documents. In all other cases, the Owner shall bear the cost of the referee testing of that lot.

305.08.04 Visual Deficiencies

All surfaces deemed visually unacceptable by the Contract Administrator due to uneven application of sealer, surface damage, flushing, bleeding or contamination, shall be repaired to the satisfaction of the Contract Administrator.

305.08.04.01 Repairs

All surfaces deemed unacceptable due to uneven application of sealer shall be repaired.

Deficiencies other than uneven application of sealer shall be repaired by removing all deficient areas of sealed granular material, then replacing it with clean, compacted Granular A meeting the requirements specified in OPSS 1010 and OPSS 501.

All repaired areas shall be resprayed with the same sealer type or a sealer with a lower sealer type number, as originally specified in the Contract Documents.

305.09 MEASUREMENT FOR PAYMENT

305.09.01 Granular Sealing

305.09.01.01 Actual Measurement

Measurement shall be by the area sealed in square metres or by mass in kilograms of sealer used, as specified in the Contract Documents.

305.09.01.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurements shall be based on the units shown in the clause under Actual Measurement.

305.10 BASIS OF PAYMENT

305.10.01 Granular Sealing

305.10.01.01 Granular Sealing - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

Sprayed areas damaged by the Contractor's operations or identified by the Contract Administrator as being inadequately treated shall be repaired and resprayed, at no additional cost to the Owner.

Sprayed areas damaged by others shall be repaired and resprayed and shall be administered as a Change in the Work.

305.10.01.02 Payment Adjustments for Sealers

305.10.01.02.01 General

Payment for any lot of sealer that does not meet all Contract requirements shall be subject to a price adjustment. A calculated price adjustment shall be determined through a system of adjustment points based on the test results for any lot sample, provided the sample remains in a condition suitable for testing.

Adjustment points related to the test results for each test shall be individually rounded to one decimal place according to LS-100.

The total number of adjustment points for the tested sample representing a lot shall be divided by 25 to obtain the payment adjustment, expressed as a percentage for the lot.

A fixed adjustment of 50% of the Contract price shall be made for lots to which at least one of the following conditions apply:

a) A lot sample has not been received by the QA laboratory within sufficient time for the sample to be tested;

b) The lot sample contains insufficient material for testing; or

c) The lot sample does not remain in a condition suitable for testing for 14 Days after sampling (e.g., broken emulsion or foam over during distillation).

305.10.01.02.02 Adjustment Points for Type I-a Sealers

For each lot, the total number of adjustment points shall be equal to the summation of the number of units that each test deviates from the specification limits times the multiplier specified for each particular test in Table 3.

305.10.01.02.03 Adjustment Points for Type I-b and Type II Sealers

For each lot, the total number of adjustment points shall be equal to the summation of the number of units that each test deviates from the specification limits times the multiplier specified for each particular test in Table 4, plus:

a) 1,000 adjustment points, if the test result for the LS-218, the Particle Charge Test, fails to meet the requirement specified in OPSS 1103; plus

b) 1,000 adjustment points, if the test result for LS-221, the Storage Stability Test, 24 hour, fails to meet the requirement specified in OPSS 1103.

305.10.01.02.04 Adjustment Points for Type III Sealers

For each lot, the total number of adjustment points shall be equal to 62.5 for every 0.1% less than 8% solids for the sample tested according to the procedure given in OPSS 2510 plus an additional 1000 adjustment points, if the material is determined to be anionic according to the Particle Charge Test, LS-218.

TABLE 1
Application Rates and Temperatures

Type of Sealer	Application Rate (kg/m²)		Application Temperature
	Hand-Sprayed Areas	Machine-Applied/Other Areas	
I-a	3.4	2.6	30 to 45 °C
I-b	3.4	2.6	At Manufacturer's Recommendations
II			
III	5.5	4.5 (Note 1)	Ambient Temperature (Note 2)

Notes:
1) Type III sealers shall be applied in 2 or 3 coats for emulsions with 12% and 8% solids, respectively, to deliver a total of 4.5 kg/m2.

2) Type III sealers shall not be applied if there is any chance that the ambient temperature will reach 0 °C or below within 24 hours after application.

TABLE 2
Lot Sizes

Tender Quantity in m² or kg		Lot Size (Maximum)
Sealed Area in m²	Mass of Sealer Used in kg	
< 500	< 1500	Sampling and Testing at CA's Discretion
500 to 5,000	1,500 to 15,000	One lot
> 5,000 to 10,000	>15,000 to 30,000	5,000 m² / 15,000 kg
> 10,000 to 50,000	>30,000 to 150,000	10,000 m² / 30,000 kg
> 50,000	> 150,000	20,000 m² / 60,000 kg

TABLE 3
Tests, Units, and Multipliers for Type I-a Sealers

Test Method	Test Description	Unit	Multiplier
ASTM D 402	Residue by Distillation to 360 °C	%	200
ASTM D 402	Distillate, as % of Total Distillate to 360 °C to 190 °C to 225 °C to 260 °C to 316 °C	 % % % %	 10 10 10 10
LS-202	Kinematic Viscosity at 60 °C	mm²/s	20
Tests on Residue			
LS-200	Residue Penetration at 25 °C	0.1 mm	15
LS-204	Residue Solubility	%	10
LS-205	Residue Ductility at 25 °C	cm	10

TABLE 4
Tests, Units, and Multipliers for Type I-b and Type II Sealers

Test Method	Test Description	Unit	Type I-b Multiplier	Type II Multiplier
LS-216	Residue by Distillation	%	200	200
LS-217	Oil Portion of Distillate, By Volume	%	50	50
LS-219	Viscosity at 50 °C, Less Than Minimum	Saybolt Furol Seconds	30	-
	Viscosity at 50 °C, Greater Than Maximum	Saybolt Furol Seconds	5	-
LS-219	Viscosity at 25 °C, Less Than Minimum	Saybolt Furol Seconds	-	30
	Viscosity at 25 °C, Greater Than Maximum	Saybolt Furol Seconds	-	5
LS-223	Sieve Test	%	-	1000
ASTM D 1310	Flash Point, Open Tag	°C	10	-
Tests on Residue				
LS-200	Residue Penetration at 25 °C	0.1 mm	15	15
LS-204	Residue Solubility	%	10	10
LS-205	Residue Ductility at 25 °C	cm	10	10

WARRANT: Always with this tender item.

Appendix 305-A, November 2016
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

Sampling requirements shall be as specified below and elsewhere in the Contract Documents.

Security measure shall be implemented for referee sample pick-up and delivery. Contractor should be responsible because of time to delivery and adjustment.

The designer should determine if a particular Sealer Type [I, II or III] should be specified in the Contract Documents (305.05).

The designer may choose the appropriate sealer on the basis of the expected number of years when the shoulder would typically need to be re-sealed as follows:

Sealer Type	Expected # of Years Before Re-Sealing*
I	4
II	3
III**	2

*Note: * The expected years shown below are based on the understanding that the shoulder will only be occasionally subjected to vehicular traffic. Note that all sealers shown below should perform behind guiderails for at least 3 years when they're being applied, in accordance with the manufacturer's requirements.

**Type III should only be selected where there is a minimal risk of the shoulders being subjected to vehicular traffic.

Granular Sealer Type III, should only be applied to aggregates meeting the requirements of Granular A, S, or M.

The designer should ensure that the General Conditions of the Contract and the 100 Series General Specifications are included in the Contract Documents.

- Areas designated for granular sealing. (305.07.03)

- Number of Business Days for the delivery of samples. (305.08.01)

- Name and location of the testing laboratory. (305.08.01)

- Unit of measurement for granular sealer. (305.09.01.01)

Related Ontario Provincial Standard Drawings

OPSD 210.070 Granular Sealing

Note: The MUNI implemented in November 2017 replaces OPSS 307 COMMON, April 2012 with no technical content changes.

CONSTRUCTION SPECIFICATION FOR STOCKPILING OF PATCHING MATERIALS AND PATCHING OF ASPHALT PAVEMENT

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307-A **Commentary**

307.01 SCOPE

This specification covers the requirements for transportation and stockpiling of patching materials and the patch repairs to asphalt pavement using SC-800 patching material, emulsified asphalt patching material, or proprietary cold patching material (PCPM).

307.01.01 Specification Significance and Use

This specification has been developed for use in provincial- and municipal-oriented Contracts. The administration, testing, and payment policies, procedures, and practices reflected in this specification correspond to those used by many municipalities and the Ontario Ministry of Transportation.

Use of this specification or any other specification shall be according to the Contract Documents.

307.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

307.02 REFERENCES

When the Contract Documents indicate that provincial-oriented specifications are to be used and there is a provincial-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.PROV, unless use of a municipal-oriented specification is specified in the Contract Documents. When there is not a corresponding provincial-oriented specification, the references below shall be considered to be to the OPSS listed, unless use of a municipal-oriented specification is specified in the Contract Documents.

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 309 Cold Mixed, Cold Laid, Open and Dense Graded Bituminous Mix

Ontario Provincial Standard Specifications, Material

OPSS 1003 Aggregates - Hot Mix Asphalt
OPSS 1152 SC-800 Patching Material
OPSS 1153 Emulsified Asphalt Patching Material

Ontario Ministry of Transportation Publications

MTO Laboratory Testing Manual:
LS-282 Quantitative Extraction of Asphalt Cement and Analysis of Extracted Aggregate from Bituminous Paving Mixtures
LS-289 Workability of Cold Bituminous Patching Materials by Blade Resistance Method

307.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Binder means the approved bituminous binding material conforming to the manufacturer's product specification.

Manufacturer means the company that produces the PCPM being used.

Manufacturer's Product Specification means the manufacturer's PCPM specification, including the ingredients that were submitted to obtain Owner approval of the PCPM.

Manufacturer Terminal means the location where the final PCPM is produced, without further blending or modification prior to distribution to the work site.

Proprietary Cold Patching Material (PCPM) means a cold patching mix consisting of binder and aggregates, and manufactured by a specific company.

307.04 DESIGN AND SUBMISSION REQUIREMENTS

307.04.01 Design Requirements

307.04.01.01 Proprietary Cold Patching Material

PCPM to be stockpiled shall be capable of maintaining its effective properties for a minimum period of 8 months from the date of supply.

307.04.02 Submission Requirements

307.04.02.01 Proprietary Cold Patching Material

A copy of the manufacturer's product specification shall be submitted to the Contract Administrator at least 7 Days prior to delivery of the mix.

307.05 MATERIALS

307.05.01 SC-800 Patching Material

SC-800 patching material shall be according to OPSS 1152 and this specification.

307.05.02 Emulsified Asphalt Patching Material

Emulsified asphalt patching material shall be according to OPSS 1153 and this specification.

307.05.03 Proprietary Cold Patching Material

The PCPM shall be according to the manufacturer's product specification and this specification, and shall be either a summer or winter mix category as specified in the Contract Documents. The PCPM shall be supplied directly from the manufacturer's terminal without further blending or modification.

The aggregates used in the PCPM shall consist of clean, hard, durable particles meeting the physical requirements for Superpave 12.5 as specified in OPSS 1003.

All PCPM supplied shall be uniformly coated.

307.06 EQUIPMENT

307.06.01 Placement and Compaction

Suitable method, equipment, and hand tools or according to the Equipment section of OPSS 309 shall be used for placing and compaction of patching materials.

307.07 CONSTRUCTION

307.07.01 Stockpiling

Stockpiles shall be built at locations specified in the Contract Documents to a maximum height of 3 m. Stockpiles shall be constructed in such a manner that compaction, other than by the weight of the material itself, shall not result.

Equipment shall not be run over the surface of the stockpile.

307.07.02 Delivery

The mixture shall be transported in vehicles with smooth metal boxes in good and leak-proof condition, previously cleaned of all foreign materials.

Truck boxes shall be lightly coated with a uniform application of a release agent just prior to loading. If liquid agent is used, the truck boxes shall be drained after each application and prior to loading.

307.07.03 Placement and Compaction

307.07.03.01 General

Asphalt repairs using patching material shall be carried out at the locations identified in the Contract Documents.

At the time of use, stockpiled patching material shall exhibit uniform coating, good cohesion and workability, and be in accordance with the material specification requirements.

The Contractor shall ensure proper adhesion of the mixture placed during the patching operation to the adjacent surfaces.

For repairs, patching material shall be placed in the repair area and compacted as specified in the Contract Documents. Placement and compaction of the patching material shall be sufficient to meet the requirements of the Surface Appearance subsection of this specification.

For repairs exceeding 50 mm in depth, the patching material shall be placed in lift thicknesses of maximum 50 mm in depth and each lift shall be compacted prior to the addition of the next lift.

307.07.03.02 SC-800 Patching Material and Emulsified Patching Material

The surface on which the patching material is placed shall be free of dirt, sand, foreign matter, and loose material and the repair area shall be free of standing water.

307.07.03.03 Proprietary Cold Patching Material

The surface on which the patching material is placed shall be free of dirt, sand, foreign matter, and loose material. Standing water in the repair area shall be removed, if required by the PCPM manufacturer's installation instructions.

307.07.04 Surface Appearance

After placement and final compaction of the patching material, patches shall be free of defective areas, including, but not limited to wheel track marking, ravelling, uneven surface, and fat spots.

307.07.05 Sampling

The Contractor shall provide patching material samples when requested by the Owner. Samples may be requested before or during the construction and from the stockpile, truck, or during placement of the material.

Samples required for stripping resistance, workability, and cohesion testing shall be a minimum 25 kg. Samples required for extraction and gradation testing shall be a minimum 15 kg.

The work shall include sampling, packaging, labelling, and delivery of the samples to the laboratory designated in the Contract Documents. Sample containers shall be supplied by the Contractor and shall be metal containers equipped with a wire handle and a tight fitted lid. Samples shall be labelled with the following information:

a) Contract No.

b) Sampling date

c) Mixture type and name

d) Sampling location

e) Manufacturer's name

f) Contractor's name

g) Weather conditions at the time of sampling

h) Sampler's name

307.07.06 Management of Excess Material

Management of excess material shall be as specified in the Contract Documents.

307.08 QUALITY ASSURANCE

307.08.01 Acceptance

Acceptance of all patching work shall be based on visual observation of the patching material, surface appearance of the patch at the time of patching, continuity with adjacent surfaces, and conformance of the patching materials to the requirements of this specification.

307.08.02 Visual Observation

During the time of patching, the mix used shall exhibit uniform coating, good cohesion, and workability.

307.08.03 Surface Appearance

All patches after final compaction shall be free of defective areas, including, but not limited to wheel track marking, ravelling, uneven surface, and fat spots. Areas showing such defects shall be deemed rejectable.

307.08.04 Sampling

Representative samples of the patching mixture may be taken at any time for testing by the Owner.

307.08.05 Testing

Patching material samples may be tested by the Owner to ensure it meets the requirements of this specification.

The Owner may request the Contractor to provide test results showing that the patching material possesses required property as determined by the following tests.

307.08.05.01 Emulsified Asphalt Patching Material and Proprietary Cold Patching Material

307.08.05.01.01 Stripping Resistance

Stripping resistance of samples shall be determined using the following procedure:

a) Place 50 g of the patching material in 400 mL of boiling distilled water in a 600 mL glass beaker.

b) Stir the mixture with a glass rod at one revolution per second for 3 minutes.

c) Once stirring is complete, visually evaluate the percentage of coating retained.

Samples with retained coatings of less than 75% shall be deemed rejectable

307.08.05.01.02 Workability

Workability of the patching material sample shall be determined according to LS-289.

Patching material with a workability index of more than 2,000 N shall be deemed rejectable.

307.08.05.01.03 Cohesion

Cohesion of the patching material sample shall be determined by LS-290.

Patching material with a cohesion index of less that 60% shall be deemed rejectable.

307.08.05.02 SC-800 Patching Material

307.08.05.02.01 Extraction and Gradation

Residual Asphalt Content and Gradation of SC-800 Patching Material shall be determined according to LS-282.

SC-800 Patching Material not complying within the requirements of the subsection for Tolerances of OPSS 1152 shall be deemed rejectable.

307.08.06 Rejection

All material and patches deemed rejectable by the Contract Administrator shall be removed and replaced. The replaced portion of the work shall meet the requirements of this specification.

307.09 MEASUREMENT FOR PAYMENT

307.09.01 Actual Measurement

307.09.01.01 SC-800 Patching Material
Emulsified Asphalt Patching Material
Proprietary Cold Patching Material

Measurement of patch material shall be by mass in tonnes as specified in the Contract Documents.

307.10 BASIS OF PAYMENT

307.10.01 SC-800 Patching Material - Item
Emulsified Asphalt Patching Material - Item
Proprietary Cold Patching Material - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Replacement of rejected materials and patches shall be at no extra cost to the Owner.

Appendix 307-A, November 2017
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should determine if the following are required and, if so, specify them in the Contract Documents:

- Winter or summer mix category of PCPM. (307.05.03)

- Stockpile locations. (307.07.01)

- Asphalt repair location. (307.07.03.01)

- Compaction requirements. (307.07.03.01)

- Location of laboratory for delivery of samples. (307.07.05)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

Note: The MUNI implemented in November 2021 replaces OPSS 309 COMMON, November 2013 with no technical content changes

CONSTRUCTION SPECIFICATION FOR COLD MIXED, COLD LAID, OPEN AND DENSE GRADED BITUMINOUS MIX

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309-A **Commentary**

309.01 SCOPE

This specification covers the requirements for production and placement of cold mixed, cold laid, open, and dense graded bituminous mix and cover aggregate.

309.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be as specified in the Contract Documents.

309.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

309.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 304	Single and Double Surface Treatment
OPSS 310	Hot Mix Asphalt

Ontario Provincial Standard Specifications, Material

OPSS 1003	Aggregates - Hot Mix Asphalt
OPSS 1006	Aggregates - Surface Treatment
OPSS 1103	Emulsified Asphalt

Ministry of Transportation Publications

MTO Laboratory Testing Manual:

LS-263	Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus
LS-265	Percent Air Voids in Compacted Dense Bituminous Pavement Mixtures
LS-266	V.M.A. in Compacted Bituminous Mixtures
LS-281	Percent Compaction of Compacted Bituminous Pavement Mixtures
LS-282	Quantitative Extraction of Asphalt Cement and Analysis of Extracted Aggregate from Bituminous Paving Mixtures
LS-301	Mix Design for Cold Mixed Dense Graded Bituminous Mixtures
LS-302	Coating Dense Graded Aggregates
LS-303	Percent Moisture Pickup in Compacted Dense Graded Bituminous Mixtures
LS-304	Coating Open Graded Aggregates
LS-305	Run Off for Open Graded Mixtures
LS-602	Sieve Analysis of Aggregates

309.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

CL mix means cold mixed, cold laid, open, or dense graded bituminous mix.

Fat Spot means an area of pavement substantially blacker than the surrounding pavement.

Segregation means a condition of the pavement characterized by areas with comparatively coarser or finer texture than that of the surrounding pavement.

309.04 SUBMISSION AND DESIGN REQUIREMENTS

309.04.01 Mix Design

The CL mix design shall be the responsibility of the Contractor. The proposed mix proportions corroborated by submission of the design proposed by the Contractor as determined by the supplier of the asphalt emulsion shall be forwarded to the Contract Administrator five Business Days before the start of production.

Mix proportions shall be determined using MTO test methods LS-301, LS-302, LS-304, and LS-305.

Aggregate samples shall be representative of the materials to be used and have proven compatibility, workability, and acceptable curing time with the emulsified asphalt selected.

309.05 MATERIALS

309.05.01 Emulsified Asphalt

The emulsified asphalt shall be according to OPSS 1103. The emulsified asphalt content shall be determined by laboratory testing and shall be within the limits set out in Table 1.

309.05.02 Aggregates

Aggregates shall meet the requirements of OPSS 1003 except that the gradations of open graded aggregates shall be according to Table 2 and dense graded aggregates shall be according to Table 3.

Sufficient aggregate to complete the work shall be stockpiled at least one week prior to use.

The cover aggregate shall be Class 4 aggregate according to OPSS 1006.

309.05.03 Cold Mixed, Cold Laid, Open and Dense Graded Bituminous Mix

309.05.03.01 General

The CL mix shall show good asphalt dispersion, uniform coating, and cohesion.

309.05.03.02 Open Graded Mix

The cure time for open graded mix shall be such that the asphalt cement residue in the emulsion will not wash off the aggregate, if water is applied one hour after compaction of the mix.

309.05.03.03 Dense Graded Mix

Dense graded mix shall be according to Table 4.

309.06 EQUIPMENT

309.06.01 Production and Placement

Mobile or stationary mixing plants shall be capable of producing a uniform thoroughly blended CL mix consisting of aggregate and emulsified asphalt. The aggregate feed system to the mixing unit shall be equipped with a means of determining the mass of material being deposited into the mixing unit prior to the addition of the emulsified asphalt. The mixing unit shall be capable of continuously maintaining the amount of emulsified asphalt added within $\pm$ 0.2% of the aggregate by weight. All measuring devices shall be calibrated according to the manufacturer's specifications at the start of the Contract and whenever deemed necessary by the Contract Administrator. The emulsified asphalt supply system shall be equipped with a flow meter and a total delivery meter.

A Midland Mix Paver or a central mixing plant, according to the Cold Mix Plants subsection, will be considered acceptable equivalents for the production of CL mixes.

Production equipment shall be properly equipped and adjusted to provide a CL mix according to this specification.

Mechanical pavers may be used to place CL mixes produced in a central mix plant and shall be according to the Paving Equipment clause of OPSS 310.

309.06.02 Cold Mix Plants

309.06.02.01 General Requirements

The equipment shall be such that the CL mix produced meets this specification and shall demonstrate adequate control and documentation of the CL mix materials for monitoring and production purposes.

309.06.02.02 Emulsified Asphalt Storage

A suitable holding tank, which has been thoroughly cleaned of any other material, shall be used.

309.06.02.03 Aggregate Feed System

A separate tapered cold feed bin with a minimum capacity of 6.0 m^3 shall be provided for each size, type, or gradation of aggregate. Partitions of sufficient height to eliminate intermingling of the aggregate shall be provided between adjoining bins. Bins shall be a minimum of 0.5 m wider than the width of the loading buckets.

A permanent scalping screen shall cover the top of each bin to remove any oversize aggregate.

Vibratory pan feeders shall not be acceptable for proportioning aggregates.

A calibrated and manually adjustable feed gate shall regulate the flow of aggregate from each bin to a conveyor feeding the pugmill. The conveyor shall be equipped with a scale indicating tonnes per minute of production and total tonnes.

309.06.02.04 Pugmill

The pugmill shall be an approved twin shaft type with a minimum capacity of 0.6 m^3 and capable of producing a uniform mix. The clearance of the blades from the inner surfaces of the pugmill shall not exceed 20 mm. The paddles shall be of a type adjustable for angular position and reversible to retard the flow of the mix if required.

The mixing time or cycle shall be adjustable.

309.06.02.05 Emulsified Asphalt Pump

The pump shall be a variable speed positive displacement pump that feeds an adjustable spray bar located at the charging end of the pugmill. The pump may also be a positive displacement pump mechanically interlocked to the aggregate feed rate mechanism, in which case, the pump must be equipped with a variable speed control.

The pump shall be equipped with a totalizing type meter with manual reset and shall indicate the flow of emulsion being pumped in litres per minute.

There shall be a satisfactory means of positive control between the flow of aggregate from the hopper and emulsion from the pump. The pump shall be interlocked, either mechanically, electrically, or hydraulically, to the aggregate feed rate control mechanism so that a constant volumetric ratio of emulsion to aggregate is fed to the pugmill.

The system shall be interlocked through a master control switch.

309.06.02.06 Discharge Holding Hopper

The plant shall be equipped with a discharge holding hopper with a minimum capacity of 1.0 tonne. It shall be operated by a control switch on the control station panel.

309.06.03 Rollers

Rollers shall be according to OPSS 310, except that three-wheel rollers will not be allowed.

309.06.04 Cover Aggregate Spreaders

Spreaders shall be according to OPSS 304 or shall be an acceptable tailgate type spreader capable of uniform application without displacement of the CL mix.

Spinner type spreaders are not allowed.

309.07 CONSTRUCTION

309.07.01 Emulsified Asphalt

Emulsified asphalt shall be thoroughly mixed with the aggregate.

309.07.02 Cold Mixed, Cold Laid, Open and Dense Graded Bituminous Mixes

309.07.02.01 Operational Constraints

Traffic shall not be permitted on the CL mix until final rolling is completed and the mix can support traffic loading without deformation.

CL mixes shall not be produced prior to May 15th or when rain is imminent. Except by special permission from the Contract Administrator, dense graded mix shall not be produced after September 15th, and open graded mix shall not be produced after September 30th. In no case shall CL mixes be produced unless the ambient temperature is at least 10 °C and rising.

309.07.02.02 Preparation of the Foundation

309.07.02.02.01 Granular Base

The granular base on which the CL mix is to be placed shall be smooth, true to grade, and free of surface float.

309.07.02.02.02 Pavement

Paved surfaces on which the CL mix is to be placed shall be free of dirt, sand, foreign matter, and loose material.

309.07.02.03 Production and Placement

CL mix of the type specified in the Contract Documents shall be produced and placed in accordance with the requirements of this specification.

When a second course is specified in the Contract Documents, any loose cover aggregate shall be swept from the surface. The previously laid course shall be adequately cured prior to placing the second or surface course.

309.07.02.04 Compaction

309.07.02.04.01 General

Initial rolling shall commence once initial breaking of the asphalt emulsion has occurred and the mix can support the roller without shoving.

Final rolling shall be done using a steel tandem roller after the cover aggregate has been applied.

309.07.02.04.02 Open Graded Mix

Each completed course of open graded mix shall have the following percent air voids in the compacted CL mix as determined by LS-265:

CL2 and CL3 - 15-20% Air Voids
CL4 and CL8 - 20-30% Air Voids

309.07.02.04.03 Dense Graded Mix

Each completed course of dense graded mix shall be compacted to at least 94% of laboratory density as determined LS-281.

309.07.02.05 Trial Application

At the start of the Contract, a trial area, 200 m in length and one traffic lane wide, shall be constructed to demonstrate that equipment, personnel, and methods of operation to be used are capable of producing an acceptable CL mix.

If deficiencies are evident during construction of the trial area, work shall be stopped until the deficiencies are corrected.

309.07.02.06 Surface Tolerance

Each course, after final compaction, shall be smooth and true to the established crown and grade and the surface of each course shall be free from deviations exceeding 6 mm as measured in any direction with a 3 m straight edge.

309.07.02.07 Surface Appearance

Each course, after final compaction, shall be of uniform texture and shall be free of segregation, fat spots, oil spills, or any other defect. Defective areas shall be removed and replaced with acceptable mix of the same type and compacted to the satisfaction of the Contract Administrator.

309.07.02.08 Sampling

Samples of the actual CL mix shall be taken by the Contractor at least twice a day and provided to the Contract Administrator. Each sample shall fill a four-litre pail.

Additional samples shall be provided when requested by the Contract Administrator.

309.07.02.09 Tolerances

The mix samples shall be according to the following tolerances:

Residual asphalt content: $\pm$ 0.3%

Aggregate retained on the 4.75 mm sieve:

For open graded mix $\pm$ 2.0%
For dense graded mix $\pm$ 6.0%

309.07.03 Cover Aggregate

After the initial rolling has taken place, cover aggregate shall be spread uniformly at a rate of 5 $\pm$ 1.5 kg/m^2 over the surface of all open graded mixes and then rolled into the CL mix.

309.07.04 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

309.08 QUALITY ASSURANCE

309.08.01 Testing

The Owner may test any samples required by this specification for conformance to specified requirements.

309.09 MEASUREMENT FOR PAYMENT

309.01.01 Actual Measurement

309.09.01.01 Emulsified Asphalt

Measurement shall be by mass in kilograms according to the requirements of the Contract Documents, except that portable and conveyor scales will not be acceptable for use.

309.09.01.02 **Open Graded CL 2**
Open Graded CL 3
Open Graded CL 4
Open Graded CL 8
Dense Graded CL
Cover Aggregate

Measurement shall be by mass in tonnes according to the requirements of the Contract Documents.

309.10 BASIS OF PAYMENT

309.10.01 **Emulsified Asphalt - Item**
Open Graded CL 2 - Item
Open Graded CL 3 - Item
Open Graded CL 4 - Item
Open Graded CL 8 - Item
Dense Graded CL - Item
Cover Aggregate - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Defective areas shall be removed, replaced with acceptable mix of the same type, and compacted to the satisfaction of the Contract Administrator at no extra cost to the Owner.

TABLE 1
Emulsified Asphalt and Residual Asphalt Content

Type of Mix	Emulsified Asphalt Content kg/t	Residual Asphalt Content by Mass (Note 1)
CL 2 Open Graded, Surface or Levelling Course	69-122	4.5 - 8.0%
CL3 Open Graded, Surface or Levelling Course	65-115	4.2 - 7.5%
CL4 Open Graded, Binder or Levelling Course	61-107	4.0 - 7.0%
CL8 Open Graded, Binder or Levelling Course	55-77	3.5 - 5.0%
Dense Graded	61-107	4.0 - 7.0%

Note:

1. As determined by test LS-282.

TABLE 2
Gradation Requirements for Open Graded Aggregates, LS-602

Sieve Designation	% Passing			
	CL 2	CL 3	CL 4	CL 8
26.5 mm				100
19.0 mm			100	95-100
16.0 mm		100	96-100	65-90
13.2 mm	100	96-100	67-86	-
9.5 mm	75-100	50-73	29-52	20-55
6.7 mm	0-40	-	-	-
4.75 mm	0-10	0-10	0-10	0-10
2.36 mm	0-5	0-5	0-5	0-5
75 μm (Note 1)	0-2	0-2	0-2	0-2

Note:

1. Open graded mix aggregates with more than 2.0% passing the 75 μm sieve will be rejected.

TABLE 3
Gradation Requirements for Dense Graded Aggregates, LS-602

Sieve Designation	% Passing
16.0 mm	100
13.2 mm	75-95
9.5 mm	50-80
4.75 mm	25-50
1.18 mm	10-40
300 μm	2-20
150 μm	0-10
75 μm (Note 1)	0-5

Note:

1. Dense graded mix aggregates can have a maximum variability of 2.0% for material passing the 75 μm sieve.

TABLE 4
Physical Requirements for Cold Mixed Dense Graded Bituminous Mix

Property of Laboratory Compacted Mixtures	Air Cured	Water Cured	MTO Test Method
Marshall Stability, N	4500 Min.	3300 Min.	LS-263
Marshall Flow Units of 0.25 mm	10 Min.	8 Min.	LS-263
% Air Voids	4-12	-	LS-265
% VMA Pass 4.75 mm by Mass			LS-266
25%	12.0	-	
37.5%	13.25	-	
50%	14.5	-	
% by Mass Moisture Pick-up	-	2 Max.	LS-303

Appendix 309-A, November 2021
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Type of CL mix. (309.07.02.03)

The designer should determine if the following is required and, if so, specify it in the Contract Documents:

- Second course of CL mix. (309.07.02.03)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

CONSTRUCTION SPECIFICATION FOR HOT MIX ASPHALT

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310-B **Supplemental Requirements for Using the MTO Performance Graded Asphalt Cement (PGAC) Price Index in Municipal Contracts**
310-C **Supplemental Requirements for Using Warm Mix Asphalt in Municipal Contracts**

310.01 SCOPE

This specification covers the requirements for the placement and compaction of hot mix asphalt designed using the Marshall or Superpave methods.

310.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

310.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

310.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 914 Waterproofing Bridge Deck with Hot Applied Asphalt Membrane

Ontario Provincial Standard Specifications, Material

OPSS 1003 Aggregates - Hot Mix Asphalt
OPSS 1101 Performance Graded Asphalt Cement
OPSS 1103 Emulsified Asphalt
OPSS 1150 Hot Mix Asphalt
OPSS 1151 Superpave and Stone Mastic Asphalt Mixtures

Ontario Ministry of Transportation Publications

MTO Laboratory Testing Manual:
LS-261 Preparation of Marshall Specimens
LS-262 Bulk Relative Density of Compacted Bituminous Mixtures
LS-263 Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus

LS-264 Theoretical Maximum Relative Density of Bituminous Paving Mixtures
LS-265 Percent Air Voids in Compacted Dense Bituminous Pavement Mixtures
LS-282 Quantitative Extraction of Asphalt Cement and Analysis of Extracted Aggregate from Bituminous Paving Mixtures
LS-287 The Determination of Percent Compaction of Compacted Bituminous Paving Mixture (MRD Method)
LS-292 Quantitative Determination of Asphalt Cement Content by Ignition and Analysis of Remaining Aggregate from Bituminous Paving Mixtures
LS-306 Bulk Relative Density of Compacted Bituminous Mixtures Using Paraffin-Coated Specimens

ASTM International

D 6752-17 Standard Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Automatic Vacuum Sealing Method

American Association of State Highway and Transportation Officials (AASHTO)

M320-16 Standard Specification for Performance Graded Asphalt Binder
M323-13 Standard Specification for Superpave Volumetric Mix Design
T40-02(2012) Sampling Bituminous Materials
T166-13 Bulk Specific Gravity of Compacted Bituminous Mixtures Using Saturated Surface-Dry Specimens
T209-12 Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures
T275-07 Bulk Specific Gravity of Compacted Bituminous Mixtures Using Paraffin-Coated Specimens

310.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

AMRL means the AASHTO Materials Reference Laboratory.

Anti-Stripping Treatment means a treatment used to minimize stripping of asphalt cement from HMA aggregates as defined in OPSS 1151.

Attribute means one of the following: Designated Large Sieve (DLS), 4.75 mm sieve, 600 µm sieve, 75 µm sieve, asphalt cement content, air voids, or compaction.

Binder Course means a HMA course between a surface course and either a granular base course or stabilized base course, an existing pavement, or another HMA binder course.

CCIL means the Canadian Council of Independent Laboratories.

Designated Large Sieve (DLS) means the sieve size specifically designated for each mix type for gradation testing according to Table 1.

Draindown means that portion of stone mastic asphalt or stone matrix asphalt (SMA) mix, fines, and asphalt cement that separates and flows downwards through the mix.

Fat Spot means an area of pavement substantially blacker than the surrounding pavement.

Hot Mix Asphalt (HMA) means hot mixed, hot laid asphaltic concrete. The terms are used interchangeably. HMA may include recycled or specialty mixes.

Hot Mix Asphalt Miscellaneous means HMA that is placed in areas other than the roadway, as specified in the Contract Documents.

Hot Mix Asphalt Padding means an HMA layer used for correcting crossfall and profile deficiencies in the existing pavement before placing the levelling, binder, or surface course.

Hot Mix Asphalt Patching means an HMA surface course placed over localized areas of distressed pavement, generally for the purpose of improving strength, rideability, or safety.

Job-Mix Formula (JMF) means the percentage passing on each designated sieve of the total mass of aggregate and the amount of asphalt cement as a percentage by mass of the mix that are based on specified mix design procedures that when mixed result in an HMA that is according to this specification.

Joint means a vertical contact between a new HMA pavement course and any HMA pavement or any rigid object that exists at the time the HMA is laid.

Levelling Course means an HMA course of variable thickness used to eliminate transverse and longitudinal irregularities on an existing surface prior to placing an HMA binder or surface course.

Lot means a specific quantity of material or a specific amount of construction normally from a single source and produced by the same process.

Mix Properties means the percent passing the DLS, 4.75 mm sieve, 600 µm sieve, and 75 µm sieve; the asphalt cement content; and the air voids.

Paving in Echelon means two or more pavers are used to pave multiple adjacent lanes simultaneously.

Performance Graded Asphalt Cement (PGAC) means asphalt cement that is produced from petroleum residue, either with or without the addition of non-particulate modifiers, according to AASHTO M320.

Protection Board means a durable panel specifically designed to provide an interface protection barrier between the HMA and the asphalt waterproofing membrane.

Quality Assurance (QA) means a system or series of activities carried out by the Owner to ensure that materials received from the Contractor meet the specified requirements.

Quality Control (QC) means a system or series of activities carried out by the Contractor to ensure that materials supplied to the Owner meet the specified requirements.

Random Sample means a sample from a location chosen by the Contract Administrator based on random numbers such that any portion of a lot or sublot has an equal probability of being selected.

Range means the numerical difference between the maximum and minimum test results within a lot.

Reclaimed Asphalt Pavement (RAP) means the processed HMA material that is recovered by partial or full-depth removal.

Referee Testing means testing by an independent laboratory selected by the Owner and acceptable to the Contractor, the results of which are used for resolving differences between QC and QA testing.

Screed means the unit of the paver that strikes off and imparts initial compaction to the HMA.

Segregation means a condition of the pavement characterized by areas with comparatively coarser or finer texture than that of the surrounding pavement.

Southern Ontario means that area of Ontario south of a line joining Waubaushene, Severn Bridge, Bancroft, and Ottawa.

Stone Mastic Asphalt or Stone Matrix Asphalt (SMA) means HMA consisting of a gap graded, stone-on-stone coarse aggregate skeleton with an asphalt cement-rich mortar.

Sublot means approximately equal divisions or portions of a lot.

Superpave means the method for specifying material components and asphalt mix design using the Superpave gyratory compactor (SGC).

Surface Course means an HMA wearing course of any flexible or composite pavement.

Vertical Surface means all edges of concrete curbs, catch basins and other appurtenances, longitudinal joints, and transverse joints for application of tack coat.

310.05 MATERIALS

310.05.01 Hot Mix Asphalt

The materials used in the production of the HMA shall be according to OPSS 1150 for Marshall mixes and OPSS 1151 for Superpave and SMA mixes.

310.05.02 Tack Coat Material

Tack coat shall consist of SS-1 or SS-1HH emulsified asphalt diluted with an equal volume of water. The undiluted material shall be according to OPSS 1103.

The use of an alternate product may be permitted at the Contractor's request, provided that such a request is submitted in writing to the Contract Administrator a minimum of 14 Days prior to the intended use of the alternate product. The Contractor's proposal shall include, but not be limited to, the following:

a) The reasons for the use of the alternate material.

b) Material Safety Data Sheets and any other information for the safe handling, transportation, and storage of the product.

c) Testing protocols to be used in confirming the properties of the material.

d) Typical test results.

e) Required application rates.

f) Cost implications for the use of the alternate product.

The Contract Administrator shall review this proposal and respond in writing within 7 Days of receiving it, either accepting the use of the alternate product or not accepting its use with reasons. The alternate product shall not be used until permission has been granted in writing by the Contract Administrator.

310.06 EQUIPMENT

310.06.01 Tack Coat Distributors

For main lane paving, tack coat shall be applied using self-propelled or tow-along pressure distributors capable of applying the product at the specified rate and in a continuous and uniform manner both longitudinally and transversely for the full lane width. The distributors shall be equipped with a volume-metering system of sufficient sensitivity to measure the quantity of tack coat dispensed, measurable to within four or five litres.

The use of a hand held pressure applicator is acceptable for tack coating protection board and small irregularly shaped areas such as tapers.

310.06.02 Paving Equipment

Asphalt pavers shall be self-propelled and capable of laying a consistent satisfactory mat that is true to the crossfall, profile, cross-section, and alignment specified in the Contract Documents. Pavers shall be equipped with hoppers and distributing augers capable of placing the HMA evenly in front of the screeds. Screeds shall be capable of being heated and being adjustable as to level and crown. Pavers shall be capable of simultaneously placing the shoulder pavement and roadway pavement whether the shoulder pavement is at the same or different crossfall from the roadway pavement.

In all cases, pavers shall be equipped with automatic longitudinal and transverse grade and slope controls capable of being operated from either side of the paver. The longitudinal grade control shall be adjustable for mat thickness in small increments, without the necessity of stopping the paver. The paver shall be equipped to operate from a 12 m ski or floating beam, a 3 m ski, or a joint matching shoe. When the ski is a flexible unit, it shall be equipped with a spring-tensioned wire extending between brackets fitted on and slightly above each end of the ski. The sensing grid shall ride on the wire, not on the ski.

Plows or other edge ramping devices that are attached to or towed by the screed portion of the paver shall not be permitted.

A 3 m straight edge shall be provided on each paver. The straight edge shall be made of metal with a level recessed in its upper surface parallel to the lower edge.

310.06.03 Rollers

310.06.03.01 Classification of Rollers

Rollers shall be classified into categories as follows:

Class S Self-propelled steel-drum, tandem, or three-wheel rollers according to Table 2.

Class R Self-propelled pneumatic-tired rollers according to Table 3.

Class V Self-propelled vibratory rollers specifically designed for HMA compaction having either dual vibratory rolls or a combination of vibratory roll and pneumatic tires with a contact area equal to or greater than 70% of the roll width according to Table 4.

310.06.03.02 Requirements for Rollers

310.06.03.02.01 General

All rollers shall be capable of reversing without backlash.

The Contract Administrator shall be provided with the mass of the rollers and may require the weighing of the rollers in his presence.

The rolls or drums shall be kept moist with water or non-petroleum based release agents to prevent adhesion of HMA to them. Excess water or release agents shall not be permitted.

310.06.03.02.02 Steel-Drum Rollers

The drums of tandem steel-drum rollers shall not be less than 1.20 m in width.

310.06.03.02.03 Pneumatic-Tired Rollers

Pneumatic-tired rollers shall be constructed so that the wheels on either the front or back oscillate either independently or in pairs. The wheels shall be mounted with smooth rubber tires. Tire inflation pressure shall be a minimum of 350 kPa when the tires are cold. All tires shall have equal pressure. Skirts or

windbreaks shall be provided at all times to protect all tires from the cooling effects of atmospheric conditions. Each roller shall be equipped with a suitable tire pressure gauge for checking tire inflation pressure.

For SMA mixes, pneumatic-tired rollers are not permitted.

310.06.03.02.04 Vibratory Rollers

Vibratory rollers shall be according to the following requirements:

a) Frequency of vibrations of the vibratory roller shall be 2,200 vibrations per minute or greater.

b) Rollers shall be equipped with provision for automatic shut-off of vibrations before coming to a stop.

310.07 CONSTRUCTION

310.07.01 Quality Control

QC procedures shall be conducted to ensure the HMA meets the requirements of the Contract Documents. The Contractor shall be responsible for the interpretation of the QC test results and the determination of any action to be taken to ensure that all materials and work are according to the requirements of the Contract Documents. QC documentation shall be made available to the Contract Administrator upon request. Sampling and testing methods shall be included in the QC documentation.

A laboratory that has current CCIL Type B Certification or AMRL equivalent certification or other equivalent certified laboratory acceptable to the Contract Administrator shall be used. Testing of the samples shall be conducted under the direction and constant supervision of technicians certified to perform the QC tests according to CCIL or equivalent certification.

310.07.02 Preparation of Foundation and Existing Pavement

310.07.02.01 Granular Grade

Prior to placing any course of HMA on a granular grade, a Class S roller of a minimum of 7 tonnes or an equivalent Class V roller with a drum width of at least 1.2 m shall be used to finish roll the grade ahead of the paver to ensure a compacted, smooth, and float-free surface. Any distortion that will impact the specified thickness of the pavement to be placed shall be repaired.

310.07.02.02 Existing Pavement

Prior to placing any HMA, all HMA and concrete surfaces shall be clean of all loose, broken, and foreign materials. Milled surfaces shall be swept with a power broom.

310.07.03 Tack Coat

310.07.03.01 Application of Tack Coat

Surfaces to be tack coated shall be free of standing water and contamination, such as mud, loose aggregate, or debris.

Protection board shall be dry and clean when the tack coat is applied.

Tack coat shall be placed sufficiently ahead of the paving operation to allow for curing.

Paving and construction equipment shall not be permitted onto the tack coat until it has broken and set.

Traffic shall be prevented from travelling upon the tack coat.

Tack coat shall be applied to the following:

a) Protection board.

b) All pavement surfaces including, but not limited to, hot mix and Portland cement concrete.

c) Milled pavement surfaces.

d) Expanded asphalt surfaces.

e) Cold-in-place recycled surfaces.

Tack coat may also be applied to other surfaces as specified in the Contract Documents.

310.07.03.02 Tack Coat Rate of Application

The diluted emulsion shall be applied at the rate of 0.35 kg/m^2 to all existing pavement surfaces, milled pavement surfaces, expanded asphalt surfaces, and any binder course surface that has been left open to traffic over at least one winter.

For cold-in-place recycled surfaces and new surfaces that have been paved in the same calendar year, the rate of application shall be 0.20 kg/m^2.

The rate of application on protection board shall be 0.50 kg/m^2.

310.07.03.03 Tack Coating of Joints

Vertical surfaces at which joints are made shall be tack coated with a thin uniform and continuous coating of tack coat material, except for longitudinal joints between lanes paved in echelon.

The joint between pavement lanes paved with an infrared joint heater shall not be painted.

310.07.04 Transportation of Hot Mix Asphalt

The HMA shall be transported from the asphalt plant to the work in leak proof truck boxes that have been previously cleaned of all foreign materials. If required, truck boxes shall be lightly coated with a uniform application of a non-petroleum based release agent. Truck boxes shall be drained after each application and before loading. No release agents shall be used that can adversely affect the quality or performance of the HMA. Release agents shall be used according to the proprietary requirements.

Each truck shall use a tarpaulin of sufficient size to completely cover the load at all times.

310.07.05 Sampling

310.07.05.01 Asphalt Cement

310.07.05.01.01 General

When specified in the Contract Documents, the Contractor shall obtain asphalt cement samples according to OPSS 1101 for QA testing.

310.07.05.01.02 Frequency and Location

The asphalt cement sampling frequencies and locations shall be as specified in the Contract Documents. A minimum of one sample shall be randomly chosen for each asphalt cement used on the Contract.

310.07.05.01.03 Labelling

Asphalt cement samples shall be labelled with the following:

a) Contract number.

b) Date (i.e., yyyy-mm-dd) and time of sampling.

c) Performance grade of the asphalt cement.

d) Supplier's name.

e) Refinery name.

f) Waybill number.

g) Tanker number.

h) Whether the sample was taken from a delivery tanker or from a storage tank at the plant.

i) Name and proportions of additives in the asphalt cement.

310.07.05.01.04 Delivery

Samples for the Owner shall be delivered within 4 hours of sampling to the location specified in the Contract Documents.

310.07.05.02 Hot Mix Asphalt

310.07.05.02.01 General

The Contractor is responsible for obtaining QA and referee HMA samples using sample plates for Marshall mixes and other methods approved by the Contract Administrator for Superpave and SMA mixes. The Contractor may obtain a QC sample at the same location of the QA and referee samples. Samples shall be taken in accordance with the Contract Documents under the direction and in the presence of the Contract Administrator. Samples shall be placed in an appropriate container supplied by the Contractor. The Contract Administrator may apply security seals to the samples prior to transportation.

310.07.05.02.02 Frequency and Location

The minimum frequency for sampling and testing shall be as specified in Table 6.

310.07.05.02.03 Labelling

HMA samples shall be labelled with the following:

a) Contract number.

b) Location of sampling.

c) Date (i.e., yyyy-mm-dd) and time of sampling.

d) Asphalt type.

310.07.05.02.04 Cores

When a coring and testing program is undertaken to resolve a dispute related to HMA compaction, the Contractor shall be responsible for all traffic control required to carry out the coring, obtaining and labelling the core samples, delivery of the samples to a mutually agreed upon third part referee laboratory, and repairing core sample holes.

Cores shall be 150 mm in diameter.

The minimum frequency of sampling and testing shall be as determined by the Contract Administrator.

Core samples shall be labelled with the following:

a) Contract number.

b) Location of core sample.

c) Date (i.e., yyyy-mm-dd) and time of sampling.

d) Asphalt type.

310.07.05.02.05 Delivery

All samples for the Owner shall be delivered within 4 hours of sampling to the location specified in the Contract Documents.

310.07.05.03 Repair of Sampling Locations

HMA and compaction requirements for filling all sample holes shall be the same as the adjacent undisturbed pavement. All sample holes shall be cleaned, dried, and filled and then compacted using a mechanical, self-powered gas, electric, or air powered compactor immediately after sampling.

310.07.06 Placing Hot Mix Asphalt

310.07.06.01 General

Prior to roller compaction, obvious defects in the HMA material placed shall be corrected. Irregularities in the alignment and grade along the outside edges shall be corrected.

A through lane paving course shall be completed prior to the placement of adjacent side roads, speed change lanes, and other paved areas. For all courses, each adjacent lane shall be completed to approximately the same location at the end of each day's paving.

At the end of each completed portion and prior to opening the lanes to traffic, the completed sections of HMA course shall be ramped transversely to the existing pavement to a maximum of 30H:1V. In all cases, the ramps shall not form part of the permanent asphalt pavement and shall be removed prior to continuing paving operations.

The temperature of the HMA prior to placement shall be within the temperature range that corresponds to the PGAC manufacturer's recommended mix temperature.

The temperature of the HMA immediately after spreading and prior to initial rolling shall not be less than 120 °C.

310.07.06.02 Operational Constraints

Paving shall not be carried out if the roadbed is frozen.

The granular grade shall be free of standing water at the time of HMA placement.

The surface of a pavement upon which HMA is to be placed shall be dry at the time of HMA placement. An HMA course shall not be placed on a previously laid course until a minimum 4 hours have elapsed, following final compaction of the previous course, and the temperature of the previous course is 60 °C or less.

Binder courses shall not be placed unless the air temperature at the surface of the road is a minimum of 2 °C and rising.

For surface course, the air temperature at the surface of the road shall be at least 7 °C, except for SMA and Superpave 12.5 FC2, the air temperature at the surface of the road shall be at least 12 °C.

Traffic shall be kept off the SMA surface until it has cooled below 60 °C.

310.07.07 Use of Paving Equipment

Levelling, binder, and surface courses shall be laid by means of mechanical self-propelled pavers.

Pavers working in echelon shall maintain a distance of less than 60 m between them.

The longitudinal alignment of the spreader shall be controlled by the use of a string line placed at each outer edge of the pavement. The spreader shall be directed at all times by the string line and not by the edge of the preceding course, except for the trailing paver when paving in echelon.

The automatic screed controls and all compaction aids on the paver shall be operational while the HMA is being placed, except when placing padding, a levelling course, or paving around appurtenances.

Single pavers or the lead paver when paving in echelon shall be controlled as to longitudinal grade by a 12 m ski or floating beam.

The pavers shall operate continuously at a uniform speed necessary to match the output of the HMA plant. However, in no case shall the speed of the paver exceed 18 m/min.

If the HMA for surface course paving comes from more than one mixing plant, the HMA from each plant shall be placed by a separate paver.

310.07.08 Widenings and Irregular Sections

When it is necessary to hand-spread the HMA in sections adjacent to machine-laid areas, such hand-spreading shall be carried out concurrently with machine-laying operations.

a) Widenings

The HMA shall be placed in widenings so that the top of the compacted HMA is flush with the top of the existing pavement. When stepped joints are specified in the Contract Documents, the layers placed in the widening shall be placed to the top of each step in separate operations.

HMA shall be placed in the widening using equipment specially designed for this purpose.

b) Irregular Sections

In turn-outs, driveways, and other irregular sections where it is impractical to use machine methods to spread and finish the binder, levelling, or surface courses, the Contractor shall use other spreading equipment or shall spread the HMA by hand.

310.07.09 Hot Mix Asphalt Padding

HMA padding shall be carried out as specified in the Contract Documents.

310.07.10 Hot Mix Asphalt Patching

Prior to HMA patching, temporary patching material shall be removed from the locations designated for such removal in the Contract Documents. The resulting areas shall be filled and compacted with HMA, as specified in the Contract Documents.

The HMA patching material shall be machine laid to the required thickness, grade, and crossfall.

Transverse and longitudinal joints between the existing pavement and the patch shall be perpendicular butt joints formed by a milling process or keyed in, as specified in the Contract Documents.

310.07.11 Longitudinal and Transverse Joints

310.07.11.01 General

All joints shall be made to ensure a full face bond and a smooth riding surface.

Longitudinal and transverse butt or stepped joints between the new HMA pavement and the existing pavement shall be constructed by trimming the existing pavement edge to a straight clean vertical surface of at least 40 mm.

All dirt or other foreign material and all loose material shall be removed from all vertical surfaces.

When matching a compacted joint, the depth of the uncompacted mat shall be set to allow for compaction. The paver screed shall overlap the adjoining mat by no more than 50 mm.

310.07.11.02 Longitudinal Joints

Longitudinal joints shall be properly set up, with the back of a rake or lute, at the proper height and grade prior to rolling, unless the Contractor has demonstrated acceptable joint construction.

For multiple lifts of HMA, the width of subsequent courses shall be staggered to an offset of 150 to 300 mm so that longitudinal joints do not coincide. This shall also apply to the joint between through lanes and speed change lanes and other similar longitudinal joints. The longitudinal joints in the surface course shall correspond to the demarcation between the driving lanes, speed change lanes, and tapers specified in the Contract Documents.

During surface course paving, excess material shall not be cast onto the surface of the freshly laid mat.

When resurfacing against a rigid object, a butt joint shall be constructed by milling the existing pavement to provide an exposed vertical surface of at least 25 mm at the face of the rigid object. The milling shall be feathered out to zero over a minimum length of 1.25 m from and parallel to the exposed face of the rigid object providing a minimum of 40 mm of resurfacing material over the area of removal.

310.07.11.03 Transverse Joints

The paver shall not move more than 15 m from any transverse joint until that joint has been rolled and checked with a straight edge. If the joint is not satisfactory, it shall be corrected immediately before the paver is allowed to proceed.

Joints between HMA pavement laid under this Contract and existing HMA courses not laid under this Contract shall be constructed as follows:

a) When a binder course is placed flush against an existing HMA pavement and a butt joint is to be made, the existing pavement shall be trimmed back to form a straight vertical surface.

b) When a surface course is placed flush against an existing HMA pavement, a stepped joint shall be prepared by removing the existing surface course to its full depth for a minimum length of 0.5 m and the remaining face shall be trimmed to form a straight vertical surface.

c) When a binder course and surface course are not placed flush against an existing HMA pavement, the binder course shall be feathered out and the surface course shall be butt jointed by removing the existing surface course to a minimum depth of 40 mm and for a longitudinal distance not less than 3 m.

310.07.11.04 Paving on Bridge Decks

The temperature of the HMA immediately after spreading shall not be less than 115 ^{o}C. The temperature of the HMA mat ahead of initial rolling shall be measured and recorded. Compaction shall be accomplished using, as a minimum,

a) a Class S roller with a minimum mass of 9 tonnes and minimum mass of 4.5 kg per mm total roll width, and

b) a Class R roller with a minimum mass of 18 tonnes and minimum mass of 2,500 kg per tire.

The operating speed of Class S rollers shall not exceed 5 km/h and shall be operated in a manner to avoid undue displacement of the HMA. If Class V rollers are used, they shall be used in static mode. Rollers shall operate with the drive wheel forward in the direction of paving.

The mixture shall be uniformly compacted as soon after placing as it can support the rollers without checking or undue displacement. Rolling shall start longitudinally at the lower edge and proceed towards the higher edge of the course, overlapping on successive passes. Alternate passes of the roller shall be staggered.

Passes by the Class R roller shall overlap previous passes. The roller shall be operated to prevent pick-up of the HMA on the tires.

310.07.12 Compaction

310.07.12.01 Rolling

310.07.12.01.01 Static Rolling

Compaction shall be accomplished using the minimum combination number of rollers specified in Table 5.

The Contractor shall determine the correct sequence of rollers used for compacting in order to achieve compaction requirements.

The operating speed of steel drum rollers shall not exceed 5 km/h and shall be operated in a manner to avoid undue displacement of the mix. Rollers shall operate with the drive wheel forward in the direction of paving.

Rolling procedures shall be as follows:

a) Breakdown Rolling

The mix shall be uniformly compacted as soon after placing as it can support the roller without checking or undue displacement. Rolling shall start longitudinally at the lower edge and proceed towards the higher edge of the course, overlapping on successive passes. Alternate passes of the roller shall be staggered.

b) Intermediate Rolling

The intermediate roller shall follow the breakdown roller as closely as possible. Passes shall overlap previous passes. The roller shall be operated to prevent pick-up of the HMA on the tires.

c) Finish Rolling

Finish rolling shall start longitudinally at the higher edge and proceed towards the lower edge.

310.07.12.01.02 Vibratory Rolling

For all HMA being compacted on bridge decks, vibratory rollers shall be operated in static mode.

310.07.12.02 Compaction of Irregular Sections and Inaccessible Areas

At all places not accessible to rollers, the mix shall be compacted by mechanical, self-powered gas, electric, or air powered equipment.

310.07.13 Tolerances

After final compaction, each course shall be smooth and true to the established crown and grade. HMA binder and surface courses shall be free from deviations exceeding 6 mm and 3 mm, respectively, as measured in any direction with a 3 m straight edge.

310.07.14 Surface Appearance

Each course after final compaction shall be of uniform texture and shall be free of defects such as segregation, fat spots, oil spills, and roller marks. Defective areas shall be removed and replaced with HMA of the same type and compacted to the satisfaction of the Contract Administrator.

If the Contractor's actions fail to prevent continued medium or severe segregation regardless of cause, the Contract Administrator may instruct the Contractor to cease paving until the problem has been corrected.

From the time that the Contractor receives notification of midlane segregation, the Contractor shall be allowed a maximum of 500 tonnes of mix to be placed on the Contract, in order to demonstrate the effectiveness of any repairs and adjustments that have been made to a defective paver. The Contractor shall demonstrate his repairs or adjustments or both to the Contract Administrator. If the Contractor is unable to eliminate midlane segregation to the satisfaction of the Contract Administrator by making repairs or adjustments to the paver within the allowable 500 tonnes of HMA, then the Contractor shall discontinue the use of that paver.

310.07.15 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

310.08 QUALITY ASSURANCE

310.08.01 General

The Contract Administrator is responsible for conducting QA procedures for all HMA aggregates, asphalt cement, and compaction to meet the requirements of the Contract Documents. QA HMA testing shall be conducted at a frequency specified in Table 6 or as specified in the Contract Documents.

Acceptance of hot mix aggregates and asphalt cement shall be according to OPSS 1003 and OPSS 1101, respectively.

All QA testing shall be completed in a certified laboratory that is CCIL Type B and C, or AMRL accredited, or equivalent. Testing of the samples shall be conducted under the direction and constant supervision of technicians certified to perform the QA tests.

The Contract Administrator may reject visually defective HMA areas based on, but not limited to the following defects: flushing, bleeding, segregation, fat spot, surface damage, and surface contamination. Such defective HMA or areas shall be removed from the work and replaced with acceptable HMA.

When the HMA fails to consistently meet the requirements of the Contract Documents, the Contract Administrator may refuse further material until the mix properties are verified for compliance by one of the following methods:

a) For Marshall mixes, samples shall be used to determine compliance to asphalt cement content, aggregate gradation, air voids, flow, voids in mineral aggregate, and stability requirements.

b) For Superpave mixes, samples shall be used to determine compliance to asphalt cement content, aggregate gradation, and Superpave mix properties.

310.08.02 Acceptance of Tack Coat Application Rate

Tack coat application shall be visually uniform. Areas of insufficient or non-uniform tack coat coverage shall be re-sprayed. When tack coating is performed using hand held devices, the visual appearance of such areas shall be consistent with the adjacent areas of machine applied material.

310.08.03 Acceptance of Joint Painting Application Rate

The joint painting shall provide a thin, uniform, and continuous coating to the satisfaction of the Contract Administrator.

310.08.04 Aggregate Gradation and Asphalt Cement Content Acceptance

Aggregate gradation and asphalt cement content test results for HMA samples based on LS-282 and LS-292 shall meet the JMF tolerance requirements as specified in Table 7.

If the HMA is deemed borderline for aggregate gradation or asphalt cement content according to Table 7, the Contractor shall be notified in writing by the Contract Administrator and shall take immediate corrective action through process control at the HMA plant. A total of three borderline test results for the same attributes representing up to 5,000 tonnes of HMA production shall result in the work being deemed rejectable.

If the HMA is deemed rejectable according to Table 7, both the Contract Administrator and the Contractor shall review, agree, and identify the limits of rejected HMA that has been placed. Referee samples within the limits of the affected area shall be delivered by the Contractor to a mutually agreed upon third party referee laboratory to verify aggregate gradation or asphalt cement content or both. When the results from the referee samples are deemed rejectable according to Table 7, the HMA pavement shall be removed and replaced with acceptable HMA pavement. Alternatively, the Contract Administrator may accept a guaranteed maintenance bond, an increased maintenance period, or a negotiated price adjustment.

310.08.05 Hot Mix Asphalt Properties Acceptance

Marshall test results for hot mix samples based on LS test procedures shall meet the requirements specified in Table 8. The production air voids for all HMA mixes shall be evaluated according to Table 9.

If the HMA is borderline for air voids as specified in Table 9, the Contractor shall be notified in writing by the Contract Administrator and shall take immediate corrective action through process control at the HMA plant.

If the HMA does not meet Table 8 minimum requirements for Marshall stability or Marshall flow or is deemed rejectable for air voids according to Table 9, both the Contract Administrator and Contractor shall review, agree, and identify the limits of rejected HMA that has been placed. Referee samples within the limits of the affected area shall be delivered by the Contractor to a mutually agreed upon third party referee laboratory to verify Marshall test or air void results or both. When the results from the referee samples do not meet Table 8 minimum requirements or are deemed rejectable according to Table 9, the HMA pavement shall be removed and replaced with acceptable HMA pavement. Alternatively, the Contract Administrator may accept a guaranteed maintenance bond, an increased maintenance period, or a negotiated price adjustment.

310.08.06 Compaction Requirements

310.08.06.01 General

Compaction testing of the placed HMA shall meet the requirements specified in Table 10.

Nuclear density test gauge results shall be used to assess in-place compaction. When compaction test results do not meet the minimum percent compaction specified in Table 10, the Contractor shall be notified in writing and either the affected area of HMA pavement shall be removed and replaced with acceptable HMA pavement or, in the case of a dispute, the Contractor or the Owner may request that a coring and testing program be undertaken to verify compaction percentage of the mix. The cores shall be provided to the Owner and compaction shall be determined according to the Compaction Determined by Core Density Testing clause using a mutually agreed upon third party referee laboratory. When compaction results from core densities do not meet the minimum percent compaction specified in Table 10, the HMA pavement shall be removed and replaced with acceptable HMA pavement.

310.08.06.02 Compaction Determined by Nuclear Density Gauge

Compaction testing shall be conducted randomly at a minimum frequency of every 100 m per lane or 150 m^2 area.

310.08.06.02.01 Marshall Hot Mix Asphalt

Percent compaction shall be determined by comparing the nuclear density in situ Bulk Relative Density (BRD) according to LS-262 to the average plant produced HMA Maximum Relative Density (MRD) according to LS-264.

310.08.06.02.02 Superpave Hot Mix Asphalt

Percent compaction shall be determined by comparing the nuclear density in situ BRD to the average plant produced HMA MRD both according to AASHTO T209.

310.08.06.03 Compaction Determined by Core Density Testing

310.08.06.03.01 Marshall Hot Mix Asphalt

Density testing of the cores shall be in accordance with LS-287. Percent compaction shall be determined by comparing the core BRD according to LS-262 to the average MRD according to LS-264 of the plant produced HMA.

310.08.06.03.02 Superpave Hot Mix Asphalt

Density testing of the cores shall be according to AASHTO T166. If the percent water absorbed by the specimen is found to exceed 2% by volume as described in AASHTO T166, then the bulk specific gravity shall be according to AASHTO T275, LS-306, or ASTM D 6752. Percent compaction shall be determined by comparing the core BRD to the average MRD both according to AASHTO T209 of the plant produced HMA.

310.09 MEASUREMENT FOR PAYMENT

310.09.01 Actual Measurement

310.09.01.01 Hot Mix Asphalt

Measurement of each type of HMA shall be by mass in tonnes or by area in square metres as specified in the Contract Documents.

310.09.01.01.01 By Mass

When payment is by mass:

All HMA that is delivered to the Work site shall be accompanied by a truck weigh ticket showing the truck number, type of hot mix, Contract number, truck time in and out of the hot mix plant, tare mass to the nearest 50 kg, gross mass to the nearest 50 kg, net mass in kg, and the driver's signature.

The truck weigh ticket shall be printed by an electronic printer interfaced with the truck scale readout and capable of recording the tare mass, gross mass, and net mass. The tare mass for the truck shall include the vehicle, operator, fuel, spare tire, etc. The tare mass of the truck shall be taken at least once per shift.

The Contractor shall be responsible for ensuring that the truck weigh ticket or delivery ticket for each load is handed to the Contract Administrator inspecting the HMA paving operation at the time the delivery truck unloads at the paving site. The Contract Administrator may not accept delivery tickets that are not submitted at the proper time or are submitted in groups after the delivery trucks have left the paving site.

The Contractor shall permit the Contract Administrator to make random checks of the gross mass and tare mass of trucks hauling HMA by requiring them to be driven over an independent certified scale.

310.09.01.01.02 By Area

When payment is by area:

Random pavement cores, maximum 100 mm in diameter, shall be taken to verify the actual thickness approximately every 100 m along the length of the roadway or 300 m^2 of pavement surface area. The average thickness for a core shall be based on the measurement from each quadrant of the core. The average thickness for the area shall be determined by averaging the core thicknesses.

When the average thickness is more than or equal to 95% of the specified thickness, the payment area shall be the total surface area of the HMA type laid for the course.

When the average thickness is less than 95% of the specified thickness, the surface area for payment purposes shall be calculated as follows:

$$\text{Payment area} = \frac{\text{actual area} \times \text{average thickness}}{\text{specified thickness}}$$

310.09.01.02 Tack Coat

Measurement for tack coat shall be of the area applied in square metres.

310.09.01.03 Hot Mix Asphalt Miscellaneous

Measurement for HMA miscellaneous shall be of the area in square metres, regardless of the number of lifts placed.

310.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

310.10 BASIS OF PAYMENT

310.10.01 Hot Mix HL *("type")* - Item
Hot Mix HL *("type")* Patching - Item
Heavy Duty Binder Course Mix - Item
Medium Duty Binder Course Mix - Item
Dense Friction Course Mix - Item
Superpave *("type")* - Item
Superpave *("type")* Patching - Item
SMA - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Removal and replacement of the following shall be at no extra cost to the Owner:

a) Defective areas of HMA, including but not limited to those due to flushing, bleeding, segregation, fat spots, surface damage, and surface contamination.

b) HMA that does not meet the requirements of the Contract Documents.

Referee testing undertaken to resolve a dispute shall be at no extra cost to the Owner if the referee test results confirm that the HMA does not meet the minimum requirements of Table 8 or is deemed borderline or rejectable according to Table 9.

A coring, testing, and traffic control program undertaken to resolve a dispute shall be at no extra cost to the Owner if the mix compaction is confirmed to be below the minimum specified compaction.

No additional payment shall be made for any delays or costs attributed to verification of the gross mass and tare mass of trucks requested by the Contract Administrator.

310.10.02 Hot Mix Asphalt Miscellaneous - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

310.10.03 Tack Coat - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

Payment for the tack coating of protection board shall be included under the Tack Coat tender item.

Payment for the tack coating of concrete surfaces completed in association with bridge deck waterproofing shall be included in the bridge deck waterproofing item according to OPSS 914.

TABLE 1
Designated Large Sieve for Mix Types

Mix Type	Designated Large Sieve mm
Superpave 25.0	19.0
Superpave 19.0	12.5
Superpave 12.5, 12.5 FC1, and 12.5 FC2, HL 1, HL 3, HL 3F, HL 3HS, DFC, and SMA 12.5	9.5
Superpave 9.5	4.75
Superpave 4.75	2.36
HL 8, MDBC, and HDBC (Note 1)	16.0
HL 4 and HL 4F	13.2
HL 2	2.36
Note: 1. HDBC is also known as HL 8HS.	

TABLE 2
Requirements for Class S Rollers

Roller	Minimum Mass t	Minimum Mass Per mm Total Roll Width kg
S 1	7	3.5
S 2	9	4.5

TABLE 3
Requirements for Class R Rollers

Roller	Minimum Mass t	Minimum Mass Per Tire kg
R 1	8	900
R 2	18	2,500
R 3	25	3,600

TABLE 4
Requirements for Class V Rollers

Roller	Minimum Roll Diameter m	Minimum Roll Width m	Minimum Static Mass Per mm Total Roll/Tire Width kg
V1	1.00	1.40	2.0
V2	1.20	1.60	2.6
V3	1.40	1.90	2.9

TABLE 5
Maximum Production Rates Per Paver for Combinations of Rollers

Maximum Production t/h	Minimum Roller Combinations	
	Southern Ontario	All Ontario
120	S2 + R1 + S1	S2 + R2 + S1
	V1 + R1	V1 + R2
135	V2 + R1	V1 + R3
	V1 + R2	V2 + R2
150	S2 + 2 x R1 + S1	S2 + 2 x R2 + S1
	S2 + R2 + S1	S2 + R3 + S1
	V2 + R2	
200	V3 + R2	V3 + R2
220	V3 + R3	V3 + R3

TABLE 6
Sampling and Testing Frequency of Hot Mix Asphalt

Quantity Per Day Per HMA Type	**Minimum Frequency of Sampling and Testing**	**Minimum Marshall Sampling Size** **kg**	**Minimum Superpave Sampling Size** (Note 1) **kg**
≤ 500 tonnes	One sample	10	20
> 500 and ≤ 1,500 tonnes	One sample per 500 tonnes or part thereof		
> 1,500 tonnes	One sample per 500 tonnes (Note 2), minimum of 3		

Notes:

1. One additional 5 kg sample is required for SMA mixes to test for draindown.

2. The Contract Administrator may reduce the testing frequency for HMA that is consistently being produced to meet the specification requirements.

TABLE 7
Tolerances for the Job-Mix Formula Aggregate Gradation and Asphalt Cement Content

Mix	**Attribute**	**Tolerances on the Job-Mix Formula** (Note 1) **%**		
		Acceptable	**Borderline**	**Rejectable**
Surface Course	DLS, 4.75 mm Sieve size	< 5.0	5.0 to 7.5	> 7.5
	600 µm sieve size	< 3.5	3.5 to 5.0	> 5.0
	75 µm sieve size	< 2.0	2.0 to 3.0	> 3.0
Binder and Levelling Courses	DLS, 4.75 mm sieve size	< 7.0	7.0 to 10.0	> 10.0
	600 µm sieve size	< 4.5	4.5 to 6.0	> 6.0
	75 µm sieve size	< 2.0	2.0 to 3.0	> 3.0
All Mixes	Asphalt Cement Content	< 0.30	0.30 to 0.50	> 0.50

Note:

1. Tolerances on the job-mix formula apply as both plus and minus from the job-mix formula percent.

TABLE 8
Marshall Stability and Flow Properties for Hot Mix Asphalt Types

Production Properties and Test Methods	DFC	HL 1, HL 3, HL 3HS, HL 4, HL 8, HDBC, and MDBC	HL 2, HL 3F, and HL 4F
Minimum Marshall Stability: Newtons (N) at 60 °C, LS-261, and LS-263	(Note 1)	(Note 1)	(Note 1)
Marshall Flow at 3.5% Air Voids: LS-261, and LS-263	8.0 minimum	8.0 - 14.0	9.0 - 18.0
Note: 1. Stability requirements shall be according to OPSS 1150.			

TABLE 9
Air Void Criteria for Hot Mix Asphalt Types (LS-265)

Mix	Acceptable %	Borderline %	Rejectable %
DFC	2.5 to 4.5	2.0 to 2.4 and 4.6 to 5.0	< 2.0 and > 5.0
All Other Mixes	3.0 to 5.0	2.0 to 2.9 and 5.1 to 6.0	< 2.0 and > 6.0

TABLE 10
Minimum Pavement Compaction Based on Maximum Relative Density

Mix	Minimum Compaction %
HDBC, Superpave 19.0 and 25.0	91.0
All Other Mixes	92.0

Appendix 310-A, November 2017
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should be aware that excluded from the specification is recycled ratio and Owner specified use of reclaimed asphalt pavement in hot mix asphalt (HMA).

The designer should specify the following in the Contract Documents:

- HMA crossfall, profile, cross-section, and alignment. (310.06.01)

- HMA type requirements. (310.07.01)

- Sampling frequencies and locations for asphalt cement. (310.07.05.01.02)

- Asphalt cement sample delivery location. (310.07.05.01.04)

- Quality assurance (QA) sample requirements. (310.07.05.02.01)

- HMA sample delivery location. (310.07.05.02.04)

- Stepped joints when required. (310.07.08)

- HMA padding requirements. (310.07.09)

- Temporary patching material removal locations. (310.07.10)

- Existing HMA patching locations requirements. (310.07.10)

- Butt joint forming method. (310.07.10)

- Lane demarcation. (310.07.11.02)

- QA HMA testing frequency if different than OPSS 310, Table 6. (310.08.01)

- Unit of measure for each HMA type. (310.09.01.01)

The designer should determine if the following is required and, if so, specify it in the Contract Documents:

- Tack coating of surface not listed in this specification and the tack coat application rate for that surface. (310.07.03)

Application rates for tack coat may vary depending on surface characteristics. (310.07.03)

The designer may specify in a special provision when quality control (QC) test results are to be used for acceptance in place of QA test results.

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The designer may consider extending delivery times for samples required on Contracts in remote areas. (310.07.05.01.04)

The designer should be aware that there is a 4 hour delivery requirement for samples and the laboratory should be open to receive them. (310.05.01.04 and 310.07.05.02.05)

The designer may consider specifying a joint heater to address cold joint conditions. (310.06.01)

For smaller projects, the borderline category for tolerances on the job-mix formula in Table 7 may not be appropriate. The designer may consider specifying that all work represented by borderline test results shall be deemed rejectable. (310.08.03.01)

The complete tender item description for HMA should include a *"type"* of HMA according to Table 1 of OPSS 1150 for Marshall mixes and according to Tables 1 and 2 of OPSS 1151 for Superpave mixes.

For Superpave mixes, the designer should refer to the appropriate lift thickness guidelines according to National Asphalt Pavement Association (NAPA), Information Series 128, HMA Pavement Mix Type Selection Guide, page 10, Figure 5, Recommended Minimum Lift Thickness Ranges for Dense Graded Mixes. Fine and coarse graded mixes as defined using primary control sieves are defined in OPSS 1151.

The designer may refer to the Best Practices for Testing of Superpave Hot Mix Quality Control Samples guidelines developed by the Ontario Superpave Implementation Committee. When the designer is including bonus or penalty clauses or both in relation to OPSS 310, more stringent laboratory procedures should be considered.

In times of volatile asphalt cement prices, on multi-year contracts, and on Contracts with greater than 500 tonnes of machine laid HMA, municipal designers may consider using the MTO PGAC price index for payment adjustment. If the designer wishes to use the PGAC price index, Appendix 310-B should be invoked in the Contract Documents. Appendix 310-B contains information that amends OPSS 310 to include the requirements for using the MTO PGAC price index for payment adjustment on municipal contracts.

The MTO PGAC price index is available on the Ontario Ministry of Transportation website at www.raqs.mto.gov.on.ca, by clicking on Contractor, Contract Bulletin, Asphalt Price Index.

The MTO PGAC price index is only a tool for qualifying hot mix prices and is not intended as a standard asphalt cement price to be incorporated into the contract bid.

The MTO PGAC price index calculation for a given month takes in the average of the 4 weeks of the month and is published on the last day of the month.

If the designer wishes to allow the use of warm mix asphalt, Appendix 310-C should be invoked in the Contract Documents. Appendix 310-C contains information that amends OPSS 310 to include the requirements for using warm mix asphalt on municipal contracts.

The following warm mix asphalt (WMA) processes are available: wax based, chemical based, and foam based.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

Appendix 310-B, November 2017
FOR USE IN MUNICIPAL CONTRACTS, WHEN REFERENCED IN THE CONTRACT DOCUMENTS

Note: This is a non-mandatory Additional Information Appendix intended to provide supplementary requirements for the OPS specification in a municipal contract, when the appendix is invoked by the Owner. It is written in mandatory language to permit invoking it by reference in the Contract Documents. If the appendix has not been invoked by reference in the Contract Documents, it does not apply.

Supplemental Requirements for Using the MTO Performance Graded Asphalt Cement (PGAC) Price Index in Municipal Contracts

OPSS 310, Hot Mix Asphalt, is amended as follows:

310.02 REFERENCES

Section 310.02 is modified by the addition of the following to the Ontario Ministry of Transportation Publications:

Contract Bulletin:
Asphalt Price Index

310.10 BASIS OF PAYMENT

Section 310.10 is amended by the addition of the following:

310.10.04 Payment Adjustment for Changes in the MTO Performance Graded Asphalt Cement Price Index

Payment to the Contractor shall be adjusted based on changes to the MTO PGAC price index. The MTO PGAC price index shall be published monthly in the Contract Bulletin. The MTO PGAC price index shall be used to calculate the amount of the payment adjustment per tonne of new asphalt cement accepted into the Work.

The MTO PGAC price index is based on the price, excluding taxes, f.o.b. (free on board) the depots in the Toronto area, of asphalt cement grade PG 58-28 or equivalent. One MTO PGAC price index shall be used to establish and calculate the payment adjustment for all grades. The MTO PGAC price index is published on the last day of the month and shall be applied to the hot mix asphalt placed in the same month.

A payment adjustment per tonne of new asphalt cement shall be established for each month in which paving occurs when the MTO PGAC price index for the month differs by more than 5% from the MTO PGAC price index for the month prior to tender opening. When the MTO PGAC price index differential is less than 5%, there shall be no payment adjustment established for that month. Payment adjustments due to changes in the MTO PGAC price index are independent of any other payment adjustments made to the hot mix asphalt tender items.

The payment adjustment per tonne shall apply to the quantity of new asphalt cement in the hot mix asphalt accepted into the Work during the month for which the payment adjustment is established. A payment adjustment for paving work done after the approved time for completion of the Contract has expired, including the expiration of any extensions of time that have been granted, shall be the lesser of the MTO PGAC price index in the last month of the Contract or the month in which the paving is completed.

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The payment adjustment for the month shall be calculated from one of the following formula:

a) When Ip is greater than 1.05 I_{TO}, the payment adjustment per tonne of asphalt cement shall be (Ip - 1.05 I_{TO}) and the Contractor shall receive additional compensation of:

   PA = (Ip - 1.05 I_{TO}) x quantity of new asphalt cement in tonnes

b) When Ip is less than .95 I_{TO}, the payment adjustment per tonne of asphalt cement is (.95 I_{TO}- Ip) and the Owner receives a rebate of:

   PA = (.95 I_{TO} - Ip) x quantity of new asphalt cement in tonnes

   where:

   PA = payment adjustment for new asphalt cement, in dollars
   I_{TO} = MTO PGAC price index published for the month prior to Tender opening
   Ip = MTO PGAC price index published for the month in which paving occurs

The quantity of new asphalt cement includes all grades of asphalt cement supplied by the Contractor with and without polymer modifiers. For each month in which a payment adjustment has been established, the quantity shall be calculated using the hot mix quantity accepted into the Work and its corresponding asphalt cement content as required by the job mix formula except for mixes that contain reclaimed asphalt pavement (RAP).

For mixes that contain RAP, the quantity of new asphalt cement shall be determined from the difference between the asphalt cement content required by the job mix formula and the asphalt cement content of the RAP incorporated into the hot mix, as calculated by the Owner.

For mixes containing a liquid anti-stripping additive, the quantity of anti-stripping additive shall be deducted from the quantity of new asphalt cement. No other deductions shall be made for any other additives.

For progress payment purposes, payment adjustments shall be made on the monthly progress payment certificate for the months in which hot mix paving occurs.

Appendix 310-C, November 2012
FOR USE IN MUNICIPAL CONTRACTS, WHEN REFERENCED IN THE CONTRACT DOCUMENTS

Note: This is a non-mandatory Additional Information Appendix intended to provide supplementary requirements for the OPS specification in a municipal contract, when the appendix is invoked by the Owner. It is written in mandatory language to permit invoking it by reference in the Contract Documents. If the appendix has not been invoked by reference in the Contract Documents, it does not apply.

Supplementary Requirements for Using Warm Mix Asphalt in Municipal Contracts

OPSS 310, Hot Mix Asphalt, is amended as follows:

310.01 SCOPE

Section 310.01 of OPSS 310 is amended by the addition of the following:

This specification covers the requirements for the placement and compaction of warm mix asphalt (WMA) designed using the Marshall or Superpave methods.

310.03 DEFINITIONS

Section 310.03 is amended by the deletion of the definition for Hot Mix Asphalt (HMA) and replaced with the following:

Hot Mix Asphalt (HMA) means hot mixed, hot laid asphaltic concrete and includes mix produced using WMA technologies. The terms are used interchangeably. HMA may include recycled or specialty mixes.

Section 310.03 is amended by the addition of the following:

Warm Mix Asphalt (WMA) means warm mixed, warm laid asphaltic concrete produced using technologies that allow for the mixing, handling, and compaction of the asphaltic concrete mixture at a temperature typically 20 to 50 °C lower than conventional hot mix asphalt.

OPSS 310 is amended by the addition of the following:

310.04 DESIGN AND SUBMISSION REQUIREMENTS

310.04.01 Design Requirements for Warm Mix Asphalt

The Contractor shall be responsible for the following:

a) Selecting the WMA technology to be used on this Contract from recognized WMA technologies or from the WMA technologies specified in the Contract Documents.

b) The WMA mix design and the job mix formula at the anticipated WMA production temperature, both of which shall be according to the requirements detailed in the Contract Documents, except as amended by this specification.

c) Ensuring that, during the development and verification of the WMA mix design, the WMA technology does not adversely affect the asphalt cement performance grade and the WMA mixture performance.

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310.04.02 Submission Requirements for Warm Mix Asphalt

A minimum of 14 Days prior to paving with WMA, the following information shall be submitted to the Contract Administrator in writing:

a) The name of the WMA technology selected for use on the Contract.

b) The complete name and address of the WMA technology supplier, if applicable.

c) Details on how the requirements of this specification shall be met.

d) If applicable, the type and dosage of WMA additives, how the additives are to be incorporated to produce the WMA, and the WMA technology supplier's established recommendations for usage.

310.05 MATERIALS

Subsection 310.05.01 is deleted in its entirety and replaced with the following:

310.05.01 Warm Mix Asphalt

The materials used in the production of WMA shall be according to OPSS 1150 for Marshall mixes or OPSS 1151 for Superpave and SMA mixes.

The Contractor shall be responsible for the following:

a) Identifying and using a facility capable of producing the WMA according to the WMA technology supplier’s instructions for the use of its WMA technology.

b) Obtaining from the WMA technology supplier all information required for the proper preparation, handling, storage, and use of the WMA materials, including Material Safety Data Sheets.

c) Obtaining materials; producing mixes; and the transportation, storage, and use of all materials.

d) Ensuring that the WMA is produced according to the WMA technology supplier’s recommendations to prevent any deleterious effects to the finished product.

e) Using an anti-stripping additive recommended by the WMA technology supplier when an anti-stripping additive is to be incorporated into the WMA.

The WMA shall be produced within the temperature range recommended by the WMA technology supplier to achieve target compaction in the field and to meet the requirements specified in the Contract Documents.

310.06.02.02 Requirements for Rollers

The last paragraph in clause 310.06.02.02.01, General, is deleted in its entirety and replaced with the following:

The rolls or drums shall be operated according to the WMA technology supplier's requirements to avoid mat segregation or roller pickup or both.

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Subsection 310.07.04 is deleted in its entirety and replaced with the following:

310.07.04 Transportation of Warm Mix Asphalt

The WMA shall be transported from the asphalt plant to the work in leak-proof truck boxes that have been previously cleaned of all foreign materials. If required, truck boxes shall be lightly coated with a uniform application of release agent in accordance with the WMA technology supplier's recommendations. Truck boxes shall be drained after each application and before loading. No release agents shall be used that can adversely affect the quality or performance of the WMA. Release agents shall be used according to the proprietary requirements.

Each truck shall use a tarpaulin of sufficient size to completely cover the load at all times.

310.07.06 Placing Warm Mix Asphalt

310.07.06.01 General

Subsection 310.07.06.01 is deleted in its entirety and replaced with the following:

The Contractor shall provide notice of intent to pave in writing to the Contract Administrator a minimum of 7 Days prior to placing the WMA.

The WMA technology supplier‘s recommendations for placing the WMA mix shall be followed.

The temperature of the WMA immediately after spreading shall be within the limits identified in Table 11.

Prior to roller compaction, obvious defects in the WMA material placed shall be corrected. Irregularities in the alignment and grade along the outside edges shall be corrected.

A through lane paving course shall be completed prior to the placement of adjacent side roads, speed change lanes, and other paved areas. For all courses, each adjacent lane shall be completed to approximately the same location at the end of each day’s paving.

At the end of each completed portion and prior to opening the lanes to traffic, the completed sections of WMA course shall be ramped transversely to the existing pavement to a maximum of 30H:1V. In all cases, the ramps shall not form part of the permanent asphalt pavement and shall be removed prior to continuing paving operations.

310.08 QUALITY ASSURANCE

310.08.01 General

Clause 310.08.01of OPSS 310 is amended by the addition of the following:

When the selected WMA technology requires that additives be added to the asphalt cement, acceptance of the asphalt cement shall be based on the samples that contain the WMA additive. Acceptance of WMA emulsion shall be based on testing the asphalt cement residue obtained from the WMA emulsion.

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310.10 BASIS OF PAYMENT

Subsection 310.10.01 is deleted in its entirety and replaced with the following:

310.10.01 Warm Mix HL *("type")* - Item
Warm Mix HL *("type")* Patching - Item
Heavy Duty Binder Course Warm Mix - Item
Medium Duty Binder Course Warm Mix - Item
Dense Friction Course Warm Mix - Item
Superpave Warm Mix ("type") - Item
Superpave Warm Mix ("type") Patching - Item
SMA Warm Mix

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Removal and replacement of the following shall be at no extra cost to the Owner:

a) Defective areas of WMA, including but not limited to those due to flushing, bleeding, segregation, fat spots, surface damage, and surface contamination.

b) WMA that does not meet the requirements of the Contract Documents.

Referee testing undertaken to resolve a dispute shall be at no extra cost to the Owner if the referee test results confirm that the WMA does not the minimum requirements of Table 8 or is deemed borderline or rejectable according to Table 9.

A coring and testing program undertaken to resolve a dispute shall be at no extra cost to the Owner if the mix compaction is confirmed to be below the minimum specified compaction.

No additional payment shall be made for any delays or costs attributed to verification of the gross mass and tare mass of trucks requested by the Contract Administrator.

Table 11 is added:

TABLE 11
Allowable Limits for WMA Paving Temperature

Minimum Allowable WMA Paving Temperature	Maximum Allowable WMA Paving Temperature
The higher of 60 °C and the minimum temperature recommended by the WMA technology supplier.	The lower of 125 °C and the maximum temperature recommended by the WMA technology supplier.

CONSTRUCTION SPECIFICATION FOR ASPHALT SIDEWALK, DRIVEWAY, AND BOULEVARD AND FOR SIDEWALK RESURFACING

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APPENDICES

311-A **Commentary**

311.01 SCOPE

This specification covers the requirements for the construction of asphalt sidewalk, driveway, and boulevard on prepared base and for the resurfacing of existing sidewalk.

311.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be as specified in the Contract Documents.

311.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

311.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 510 Removals

Ontario Provincial Standard Specifications, Material

OPSS 1103 Emulsified Asphalt
OPSS 1150 Hot Mix Asphalt
OPSS 1151 Superpave and Stone Mastic Asphalt Mixtures

311.05 MATERIALS

311.05.01 Hot Mix Asphalt

The hot mix asphalt (HMA) for this work shall be according to OPSS 1150 or OPSS 1151. The type of HMA shall be as specified in the Contract Documents.

311.05.02 Emulsified Asphalt

The emulsified asphalt shall be undiluted SS-1 according to OPSS 1103.

311.06 EQUIPMENT

311.06.01 Roller

A hand-operated roller weighing not less than 135 kg or a self-propelled roller shall be used.

311.07 CONSTRUCTION

311.07.01 General

The HMA shall be placed on the prepared base or on the surface of the existing sidewalk to the line, grade, dimensions, and thickness shown in the Contract Documents. The prepared base shall be dry, well compacted, and approved by the Contract Administrator before work commences.

HMA shall not be placed unless the surface is dry and the air temperature is at least 7 °C and rising. HMA shall not be placed faster than it can be properly raked and screeded.

Areas inaccessible to a roller shall be compacted with hand operated hot tampers.

The sidewalks, driveways, and boulevards and the resurfaced sidewalks shall not be opened to pedestrians or vehicles until the mix has cooled sufficiently to prevent deformation.

Forms or other approved means shall be used to obtain proper line and neat uniform edges.

311.07.02 Sidewalk Resurfacing

The surface of the existing sidewalk on which asphalt is to be placed shall be thoroughly cleaned. Loose and broken material shall be removed from locations designated in the Contract Documents. Removals shall be according to OPSS 510.

Sound concrete or asphalt surfaces that are to remain shall be uniformly sprayed with emulsified asphalt at the rate of 0.5 kg/m^2. The emulsified asphalt shall form a continuous film over the surface and shall be allowed to dry until it reaches the required state of tackiness before the resurfacing course is laid.

311.07.03 Tolerances

The surface, after compaction, shall be smooth and true to the established grade and of a uniform texture.

The surface of the finished sidewalk, driveway, and boulevard shall be free from depressions exceeding 5 mm as measured with a 3 m straight edge placed anywhere on the sidewalk, parallel to the centreline.

311.07.04 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

311.09 MEASUREMENT FOR PAYMENT

311.09.01 Actual Measurement

311.09.01.01 Asphalt Sidewalk
Asphalt Driveway
Asphalt Boulevard
Sidewalk Resurfacing

Measurement of asphalt placed shall be by area in square metres.

311.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

311.10 BASIS OF PAYMENT

311.10.01 Asphalt Sidewalk - Item
Asphalt Driveway - Item
Asphalt Boulevard - Item
Sidewalk Resurfacing - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

311.10.02 Hot Mix Asphalt

HMA designated for this work shall be paid for at the Contract price for the appropriate hot mix tender item.

Appendix 311-A, November 2018
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- The type of HMA to be used. The Contract Documents should contain an HMA item for use with this specification. (311.05.01)

- The line, grade, dimensions, and thickness of HMA to be placed. (311.07.01)

- The areas of sidewalk to be removed. (311.07.02)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

CONSTRUCTION SPECIFICATION FOR ASPHALT CURB AND ASPHALT GUTTER SYSTEMS

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312.09 **MEASUREMENT FOR PAYMENT**

312.10 **BASIS OF PAYMENT**

APPENDICES

312-A **Commentary**

312.01 SCOPE

This specification covers the requirements for the construction of asphalt curb and asphalt gutter, gutter outlets, and spillways.

312.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be as specified in the Contract Documents.

312.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

312.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 206	Grading
OPSS 310	Hot Mix Asphalt
OPSS 314	Untreated Granular, Subbase, Base, Surface Shoulder, and Stockpiling
OPSS 501	Compacting

Ontario Provincial Standard Specifications, Material

OPSS 1103	Emulsified Asphalt
OPSS 1150	Hot Mix Asphalt
OPSS 1151	Superpave and Stone Mastic Asphalt Mixtures

312.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Curb and Gutter means asphalt curb, gutter, and combinations of curb with gutter.

Curb and Gutter System means asphalt curb and asphalt gutter, gutter outlets, and spillways.

312.05 MATERIALS

312.05.01 Hot Mix Asphalt

The hot mix asphalt (HMA) shall be according to OPSS 1150 or OPSS 1151. The type of HMA shall be as specified in the Contract Documents.

312.05.02 Emulsified Asphalt

The emulsified asphalt shall be undiluted SS-1 according to OPSS 1103.

312.06 EQUIPMENT

312.06.01 Roller

A hand-operated roller weighing not less than 135 kg or a self-propelled roller shall be used.

312.06.02 Asphalt Curb Machine

An asphalt curb machine shall be supplied with a template attached to the machine so that the correct cross-section is provided.

312.07 CONSTRUCTION

312.07.01 General

HMA placed shall be according to OPSS 310.

The HMA shall be placed on the prepared base to the lines, grade, and dimensions specified in the Contract Documents.

Areas inaccessible to the roller shall be compacted with hand operated hot tampers.

312.07.02 Finishing

After the compacted HMA has cooled to ambient temperature, the exposed surfaces of the asphalt curb and asphalt gutter system to 0.15 m beyond the front edge shall be sprayed with emulsified asphalt at a rate of 0.5 kg/m^2. The emulsified asphalt shall be applied before the surface becomes contaminated by any material that would prevent a proper bond.

312.07.03 Tolerances

The compacted surface shall be of uniform texture and smoothness and true to the established line and grade. The surface of the finished HMA shall be free from depressions exceeding 5 mm, as measured with a 3 m straight edge placed anywhere along the surface of the HMA and parallel to the edge.

312.07.04 Foundation and Backfill

The foundation shall be excavated, backfilled, and compacted to the grade and shape required to allow for placement of the HMA curb and gutter system to the line, grade, and dimension specified in the Contract Documents.

Excavation and embankment construction shall be according to OPSS 206.

Granular base and granular backfill construction shall be according to OPSS 314.

312.07.04.01 Compaction

Compaction shall be according to OPSS 501.

312.07.05 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

312.09 MEASUREMENT FOR PAYMENT

312.09.01 Actual Measurement

312.09.01.01 Asphalt Curb

Measurement of curb shall be by length in metres along the top of the curb.

312.09.01.02 Asphalt Gutter

Measurement of gutter shall be by length in metres along the flow line of the gutter. Such measurements shall include the spaces occupied by setbacks, gutter outlets, and frames with grates.

312.09.01.03 Asphalt Curb and Gutter

Measurement of curb and gutter shall be by length in metres along the top of the curb.

312.09.01.04 Asphalt Spillways

Measurement of asphalt spillways shall be by length in metres along the flow line from the end of gutter outlet to the spillway termination.

312.09.01.05 Asphalt Gutter Outlets

For measurement purposes, a count shall be made of the number of gutter outlets installed, without separation into types, depths, or sizes.

312.10 BASIS OF PAYMENT

312.10.01 Asphalt Curb - Item
Asphalt Gutter – Item
Asphalt Curb and Gutter - Item
Asphalt Spillways - Item
Asphalt Gutter Outlets - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

312.10.02 Hot Mix Asphalt

HMA designated for this work shall be paid for at the Contract price for the appropriate HMA tender item.

312.10.03 Excavation

Excavation required to set the various components to the required line and grade shall be considered as part of the work of installing the curb and gutter system. When such excavation overlaps excavation required for any other work under the Contract, then payment shall be made in accordance with the specification for such other work as though no excavation were required for curb and gutter construction.

312.10.04 Granular Materials

Granular materials required for the work shall be paid for at the Contract price for the appropriate granular tender item.

Appendix 312-A, November 2018
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- The type of HMA. (312.05.01)

- The lines, grade, and dimensions of the curb and gutter system. (312.07.01)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 601.010	Asphalt Curb and Asphalt Gutter
OPSD 604.020	90° Asphalt Outlet for Asphalt Gutter
OPSD 605.020	30° and 45° Asphalt Outlet for Asphalt Gutter
OPSD 605.040	Asphalt Spillways

CONSTRUCTION SPECIFICATION FOR UNTREATED GRANULAR SUBBASE, BASE, SURFACE, SHOULDER, AND STOCKPILING

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314.09 **MEASUREMENT FOR PAYMENT**

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APPENDICES

314-A **Commentary**
314-B **Granular B Type II Compaction**

314.01 SCOPE

This specification covers the requirements for the construction of untreated granular subbase, base, roadway surface and shoulder, edge ramping for bituminous pavements, and stockpiling at specified sites.

314.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be as specified in the Contract Documents.

314.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

314.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 350	Concrete Pavement and Concrete Base
OPSS 501	Compacting

Ontario Provincial Standard Specifications, Material

OPSS 1001	Aggregates - General
OPSS 1010	Aggregates - Base, Subbase, Select Subgrade, and Backfill Material

314.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Construction Grading Report means a tabular report provided by the Contract Administrator that identifies stations, offsets, and elevations for granular surfaces consistent with the design cross-section.

314.05 MATERIALS

314.05.01 Aggregates

Granular material and select subgrade material shall be according to OPSS 1010.

314.07 CONSTRUCTION

314.07.01 Granular Subbase, Base, and Surface

Material shall be kept free from clay and other types of deleterious material. The Contractor's operations shall not disturb underlying work.

Material shall be placed without segregation in uniform layers such that the thickness of the compacted layer is not greater than 150 mm, except as provided under the Modified Layer Compaction Method clause.

Each layer shall be bladed to a smooth surface according to the required cross-section and maintained until placement of a subsequent layer, when applicable.

Prior to closing down operations for the completion of each day's work, the subbase material shall be bladed and compacted and, if necessary, covered with sufficient base material to carry traffic.

The granular base shall be maintained to the tolerances in grade and cross-section and to the specified density until the project is accepted or, if the Contract includes paving, until the surface is paved.

314.07.02 Winter Grading of Granular

All ice and snow shall be removed from all portions of the Work Area. Frozen material shall not be incorporated into the Work. Material shall not be placed over frozen ground, except, at the Contractor's option, a single lift may be placed over frozen ground; in which case, final grading and compaction shall be done after the underlying material has thawed.

314.07.03 Edge Ramping of Bituminous Pavement

A ramp of the specified granular material shall be built along the outside edges of each bituminous pavement construction course. Such ramps shall be at a height level with the pavement course and fall away from its edge at a slope not steeper than 4H:1V. Care shall be taken to prevent any ramping material from being spilled or pushed onto the pavement. Any material that is spilled shall be removed immediately without damage to the pavement and the surface thoroughly cleaned with the use of a power broom or other suitable means.

Prior to paving any section, only sufficient material to construct the ramps shall be placed on the shoulders. No other shoulder material shall be placed until the conditions, as detailed in the Shoulders subsection, have been attained.

Edge ramps shall be completed prior to opening adjacent pavement to traffic.

314.07.04 Shoulders

Granular shouldering material shall be placed and compacted at locations and to the line, grade, and cross-section specified in the Contract Documents.

Before commencing shoulder construction, all debris and deleterious material shall be removed from the shoulder area.

Shouldering operations shall commence as soon as, but not before, the following pavement conditions are met:

a) Bituminous Pavements

   Placement of granular material for shouldering operations shall not commence along any section of pavement until 24 hours have elapsed from the time of completion of the final bituminous pavement course in that section. The shouldering operations shall be completed within 24 hours on sections of pavement that are open to traffic. When the pavement is not open to traffic, the shouldering shall be completed before traffic is permitted.

b) Concrete Pavement and Concrete Base

   Shouldering operations shall commence according to OPSS 350. Shouldering shall be completed before opening the concrete base or concrete pavement to traffic.

All shoulder construction material shall be conveyed from the transport vehicle onto the shoulder area. End dumping of shoulder construction material directly on to the adjacent pavement surface or directly on to the shoulder shall not be permitted. The material shall be uniformly distributed within the specified shoulder limits without segregation. Grading and shaping operations shall confine all material to within the specified shoulder limits without overspill. Any shoulder construction material deposited, dragged, or inadvertently placed on the pavement surface shall be removed immediately and the pavement surface shall be thoroughly cleaned with the use of a power broom or other suitable means.

Operation of equipment shall not cause any damage to the pavement.

314.07.05 Compaction

314.07.05.01 General

Each layer of material shall be compacted as specified before the next layer is placed.

314.07.05.02 Compaction Requirements

The compaction requirements shall be according to OPSS 501.

For Granular B Type II, compaction results may not be attainable with the use of a nuclear moisture and density gauge for larger gradation aggregates. Compaction methods may need to be modified and the use of a modified compaction method detailed in Appendix B shall be considered.

314.07.05.03 Modified Layer Compaction Method

At the option of the Contractor, granular material may be placed in layers thicker than permitted under the Granular Subbase, Base, and Surface subsection, subject to the following provisions:

a) All material shall be placed in uniform layers such that each layer shall have a depth of not more than 300 mm after compaction.

b) Before placing each material in thicker layers, the Contractor shall prove, in a two lane trial area, the ability of the proposed compaction method to achieve the specified density. The location and extent of the trial area shall be approved by the Contract Administrator. At least 48 hours notice shall be given to the Contract Administrator before any work commences on the trial area. Full details of the proposed placing and compacting system or systems, including the rate of placing, depth of layer, number and type of compaction units, and number of passes shall be given to the Contract Administrator. The areas designated to evaluate each system shall be of sufficient length to be representative of the proposed method and shall normally be approximately 150 m in length.

c) When the Contract Administrator, on the basis of test results, approves a system of placing and compacting, the system shall be used for the remainder of the work to which it is applicable, except that:

   i. Should the Contractor find it necessary at any time to change the system or any part of it, including the source of material or the rate of placing the material, the Contractor shall first obtain approval from the Contract Administrator, who may require a further trial area.
   ii. If at any time tests show that a previously approved system is no longer producing the specified compaction, the Contractor shall make whatever changes are necessary to satisfy the requirements of this specification.

314.07.06 Tolerances

314.07.06.01 General

The surface of the uppermost layer of granular material shall be bladed, shaped, and compacted to produce the specified grade and cross-section.

In the event of a conflict between meeting horizontal grading tolerances and meeting vertical grading tolerances, the vertical grading tolerance shall take precedence.

314.07.06.02 Granular Courses

The finished granular courses shall not deviate more than 30 mm from the specified grade and cross-section and the surface shall not deviate more than 15 mm at any place as measured in any direction with a 3 m straight edge.

314.07.06.03 Bituminous Courses, Sidewalk, Curb, and Gutter

The finished granular surface shall not deviate more than 30 mm from the specified grade and cross-section, except when the finished bituminous grade is controlled by fixed components such as existing pavements and curbs, in which case the finished granular surface shall not deviate more than 10 mm from the specified grade. Granular surfaces shall not deviate more than 10 mm at any place as measured in any direction with a 3 m straight edge.

314.07.06.04 Concrete Courses, Sidewalk, Curb, and Gutter

The finished granular surface shall not deviate more than 10 mm from the specified grade and cross- section and the surface shall not deviate more than 10 mm at any place as measured in any direction with a 3 m straight edge.

314.07.07 Stockpiling of Granular Material

Stockpiles of granular material shall be constructed according to OPSS 1001 at sites specified in the Contract Documents.

314.07.08 Quality Control

The Contractor shall carry out grade checks on the finished granular surfaces and carry out all QC grade checks required to ensure that the finished granular courses are built to within the specified tolerances for grade and cross-section. QC of granular grading shall be based on surface tolerances of the finished granular courses, as provided in the Tolerances subsection. The grade shall be certified at the stations and offsets shown in the Construction Grading Report.

314.07.09 Submission of Grade Checks

All grade checks relating to horizontal and vertical grading tolerances, including all non-compliances, shall be submitted to the Contract Administrator within 2 Business Days following completion of the grade.
The Contractor shall sign and certify the construction grading report as correct.

When grading templates are available, the Contractor shall sign and certify the template as correct. If no template is available, the Contractor shall complete, sign, and submit form OPSF 314-1 to the Contract Administrator.

314.07.10 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

314.08 QUALITY ASSURANCE

314.08.01 General

The Contract Administrator may conduct random QA grade checks to verify that the grade and cross-section are within the specified tolerances.

314.08.02 Finished Grades Outside Specification

When the finished granular grade or cross-section or both do not meet the acceptance criteria, the granular course shall be brought to grade or cross-section or both within the specified tolerances.

314.08.03 Acceptance

Provided that the Contract Administrator's grade checks are according to those determined by the Contractor, no action shall be taken. If discrepancies between QA and QC grade checks occur, additional QA grade checks may be conducted by the Contract Administrator. If the Contract Administrator chooses not to take QA grade checks, the work shall be accepted on the basis of QC grade checks.

If the finished grade or cross-section or both are not according to the specification, the Contractor shall be required to bring the granular surface to grade or cross-section or both within the specified tolerances and recertify the grade.

314.09 MEASUREMENT FOR PAYMENT

314.09.01 Actual Measurement

314.09.01.01 Granular A, B Type I, B Type II, B Type III, M, O, and S
Granular A, B Type I, B Type II, B Type III, M, and O Stockpiled
Granular A, B Type I, B Type II, B Type III, M, and O from Stockpile
Select Subgrade Material

314.09.01.01.01 Tonne

When payment is by the tonne:

a) When the Contractor supplies Granular A and M composed of air-cooled iron blast-furnace slag or nickel slag, the payment quantities shall be determined by applying the following factors:

   i. The total measured mass of air-cooled iron blast-furnace slag incorporated into the work shall be multiplied by a factor of 1.116.
   ii. The total measured mass of nickel slag incorporated into the work shall be multiplied by a factor of 0.85.

b) When Granular B is composed of slag, the payment quantities shall be determined by comparing the density of the material to the average density of granular material as set by the Owner for that specific area and applying the conversion factors so determined to the weighed tonnes.

c) When granular material is composed of slag, it is necessary to determine the amount of overrun or underrun. Such overrun and underrun shall be the difference between the tender quantity and the payment quantity as determined by applying the foregoing factors to the weighed tonnes.

314.09.01.01.02 Cubic Metre

When payment is by cubic metre, one of the following methods shall be employed as determined by the Contract Administrator:

a) End Area Method

   i. At Source

   The volume of material shall be measured at the source in their original location and computed in cubic metres by the method of average end areas.

   Cross-sections shall be taken after the source has been cleared, grubbed, and stripped of all unsuitable surface material.

   The volume of boulders removed from borrow pits that cannot be accommodated in embankments shall be deducted.

   ii. In Place

   When the measurement for payment of material in their original location is not possible, the measurement for payment shall be made of material measured in place with no allowance for shrinkage and computed in cubic metres by the method of average end areas.

b) Truck Box Method

Material shall be measured in cubic metres, loose, by predetermined truck box capacities. The predetermined capacity of each truck shall be that computed from its box dimensions.

Each truck shall be uniquely and readily identifiable.

314.09.01.01.03 Square Metre

When payment is by square metre, the area shall be based on that shown in the Contract Documents.

314.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

314.10 BASIS OF PAYMENT

314.10.01

Granular A - Item
Granular A, Stockpiled - Item
Granular A, from Stockpile - Item

Granular B Type I - Item
Granular B Type I, Stockpiled - Item
Granular B Type I, from Stockpile - Item

Granular B Type II - Item
Granular B Type II, Stockpiled - Item
Granular B Type II, from Stockpile - Item

Granular B Type III - Item
Granular B Type III, Stockpiled - Item
Granular B Type III, from Stockpile - Item

Granular M - Item
Granular M, Stockpiled - Item
Granular M, from Stockpile - Item

Granular O - Item
Granular O, Stockpiled - Item
Granular O, from Stockpile - Item

Granular S - Item
Select Subgrade Material, Compacted - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

The cost of any additional QA grade checks on the recertified area shall be the responsibility of the Contractor. All grading carried out by the Contractor as a result of QA grade checks to ensure tolerances shall be carried out at no additional charge to the Owner.

Compensation for the cleanup of the stockpile site on completion of the operation, when required, shall be included as part of the granular item cost.

314.10.02 From Stockpile

Compensation for clearing, grubbing, stripping, cleanup of the stockpile site, and for supplying and placing a pad upon which the materials are to be stockpiled shall be included as part of the granular item cost.

CERTIFICATION OF GRADE ELEVATION / CROSSFALL

CONTRACT _____ **LOCATION** _____

COMPONENTS _____ **LOCATION** _____

In compliance with the Contract, I hereby certify that the following component of the work has been correctly constructed to the specified line and grade tolerances.

FROM STATION	TO STATION	TYPE OF GRADE	DATE	CERTIFIED BY	
				Print name	Signature

OPSF 314-1

Appendix 314-A, Commentary for OPSS.MUNI 314, November 2019
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Location, line, grade, and cross-section for granular material. (314.07.04)

- Sites for stockpiles of granular material. (314.07.07)

On projects requiring grading, the designer should provide a Construction Grading Report.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

Appendix 314-B, November 2019
FOR USE IN MUNICIPAL CONTRACTS, WHEN REFERENCED IN THE CONTRACT DOCUMENTS

Note: This is a non-mandatory Additional Information Appendix intended to provide supplementary requirements for the OPS specification in a municipal contract, when the appendix is invoked by the Owner. It is written in mandatory language to permit invoking it by reference in the Contract Documents. If the appendix has not been invoked by reference in the Contract Documents, it does not apply.

Supplemental Requirements for Using the MTO Performance Graded Asphalt Cement (PGAC) Price Index in Municipal Contracts

OPSS 314, Untreated Granular Subbase, Base, Surface, Shoulder, and Stockpiling is amended as follows:

314.07.05.02 Compaction Requirements

Clause 314.07.05.02, Compaction Requirements, is amended by the addition of the following:

Material shall not be dumped into position, but shall be deposited on and pushed over the end of the lift being constructed by means of bulldozers or other approved equipment.

The placement of the first lift of material over wet or weak subgrade shall be monitored and the placement and compaction procedure modified as required, with the approval of the Contract Administrator, to minimize subgrade disturbance. Localized, unusually wet or weak subgrade areas shall be identified to the Contract Administrator for possible treatment

In restricted zones, as specified in OPSS 501, Granular B, Type II shall be compacted using hand-operated vibratory equipment with a minimum operating mass of 400 kg and a maximum power output between 5.0 and 9.9 kW. Where confined areas are less than the minimum width and where such equipment can be used safely, then smaller vibratory hand-operated tampers shall be used. One hundred percent compaction coverage with a minimum of four passes shall be provided in all cases.

In non-restricted zones, Granular B, Type II shall be compacted using single drum, vibratory, smooth steel drum rollers, with a minimum operating mass of 5,000 kilograms and minimum operating dynamic force of 75 kN. One hundred percent roller pass coverage with a minimum number of four passes shall be provided. Each roller pass shall overlap the coverage of the preceding pass by a minimum of 0.5 m.

CONSTRUCTION SPECIFICATION FOR EXTRUDED EXPANDED POLYSTYRENE FROST HEAVE TREATMENT

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316.05 **MATERIALS**

316.06 **EQUIPMENT - Not Used**

316.07 **CONSTRUCTION**

316.08 **QUALITY ASSURANCE - Not Used**

316.09 **MEASUREMENT FOR PAYMENT**

316.10 **BASIS OF PAYMENT**

APPENDICES

316-A **Commentary**

316.01 SCOPE

This specification covers the requirements for the installation of extruded expanded polystyrene insulation for frost heave treatment of pavements.

316.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be as specified in the Contract Documents.

316.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

316.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 206	Grading
OPSS 308	Tack Coating and Joint Painting
OPSS 314	Untreated Granular Subbase, Base, Surface, Shoulder, and Stockpiling
OPSS 501	Compacting

Ontario Provincial Standard Specifications, Material

OPSS 1010	Aggregates - Base, Subbase, Select Subgrade, and Backfill Material
OPSS 1103	Emulsified Asphalt
OPSS 1605	Extruded Expanded Polystyrene Pavement Insulation

316.05 MATERIALS

316.05.01 Extruded Expanded Polystyrene

Extruded expanded polystyrene insulation shall be according to OPSS 1605 and supplied in sheets 600 x 2400 mm.

Grade and compressive strength of the extruded expanded polystyrene insulation shall be as specified in the Contract Documents.

316.05.02 Emulsified Asphalt

The emulsified asphalt shall be undiluted SS-1 according to OPSS 1103.

316.05.02 Tack Coat

Tack coat shall be according to OPSS.PROV 308.

316.05.03 Granular

Granular base and subbase shall be according to OPSS 1010.

When Granular B is used as backfill, 100% of the material shall pass the 75 mm sieve.

316.07 CONSTRUCTION

316.07.01 General

The site shall be prepared and extruded expanded polystyrene insulation placed and covered with compacted granular material.

316.07.02 Site Preparation

316.07.02.01 Excavation

The excavation shall be carried out to the dimensions specified in the Contract Documents. The tolerance of the earth grade on which the extruded expanded polystyrene is to be placed shall be according to OPSS 206 and the surface shall not deviate by more than 10 mm at any place on a 3 m straight edge.

All protruding material such as cobbles, boulders, and roots exceeding 50 mm in any dimension shall be removed from the surface.

316.07.02.02 Pavement Surface

The pavement surface shall be cleaned of all earth, granular, and any other debris before tack coat is placed.

316.07.03 Placing Extruded Expanded Polystyrene

316.07.03.01 General

Extruded expanded polystyrene sheet treatment shall be placed and secured. The sheets shall be placed lengthwise and parallel to the centreline of the roadway to obtain butt joints and staggered transverse joints. The area to be treated and the insulation thickness shall be as specified in the Contract Documents.

316.07.03.02 Securing

Each sheet of extruded expanded polystyrene may be secured by placing sufficient granular material to ensure that no movement takes place during subsequent operations.

Alternatively, hardwood skewers 10 mm in diameter and 150 mm in length shall be used to secure the extruded expanded polystyrene to the prepared surfaces.

When extruded expanded polystyrene is placed directly on pavement surface, tack coat shall be applied to the existing pavement surfaces to provide a secure bond between the extruded expanded polystyrene and the pavement surface. The tack coat shall be applied at a rate of 0.35 kg/m^2. The extruded expanded polystyrene shall be placed while the tack coat is still tacky.

316.07.04 Granular Material

Granular base or subbase material shall be placed according to OPSS 314; except, the initial lift of granular material for protection of extruded expanded polystyrene from construction traffic shall be the depth specified in the Contract Documents placed in one lift by end dumping and spreading.

Vehicular traffic shall not be permitted on the extruded expanded polystyrene sections until the full depth of the entire granular base and subbase courses have been placed and compacted according to OPSS 501.

316.07.05 Management of Excess Material

Management of excess material shall be as specified in the Contract Documents.

316.09 MEASUREMENT FOR PAYMENT

316.09.01 Actual Measurement

316.09.01.01 Extruded Expanded Polystyrene Treatment

Measurement of extruded expanded polystyrene shall be by area in square metres.

316.09.01.02 Tack Coat

Measurement of tack coat shall be by area in square metres.

316.10 BASIS OF PAYMENT

316.10.01 Extruded Expanded Polystyrene Treatment - Item
Tack Coat - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

316.10.02 Excavation

Payment for earth and rock excavation shall be according to OPSS 206.

316.10.03 Granular Base and Subbase

Payment for granular base and subbase material placed over the polystyrene shall be according to OPSS 314.

Appendix 316-A, November 2018
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Grade and compressive strength of the insulation. (316.05.01)

- Excavation limits. (316.07.02.01)

- Insulation thickness and area to be treated. (316.07.03.01)

- Depth of the initial lift of granular base or subbase material to be placed over the extruded expanded polystyrene to allow for construction traffic. (316.07.04)

The placing of extruded expanded polystyrene sheets over frost susceptible soil prevents the penetration of frost beyond a predetermined depth. When it is decided to treat a frost heave without excavating, polystyrene is placed right on the surface of the existing pavement and covered with granular.

Typical thicknesses of the extruded expanded polystyrene treatments are 25 mm in Southern Ontario and 40 mm in Northern Ontario. Increasing the thickness of insulation may result in an increased risk of differential icing.

Due to differential icing concerns with extruded expanded polystyrene frost heave treatments, the designer should consider limiting treatment to tangent sections avoiding curves, crests of hills, and intersections.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 514.010	Extruded Expanded Polystyrene Frost Heave Treatment, 25 mm Thickness
OPSD 514.020	Extruded Expanded Polystyrene Frost Heave Treatment, 40 mm Thickness

CONSTRUCTION SPECIFICATION FOR OPEN GRADED DRAINAGE LAYER

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320-A **Commentary**

320.01 SCOPE

This specification covers the requirements for materials, construction, and testing of asphalt cement and Portland cement treated open graded drainage layer.

320.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

320.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

320.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 313 Hot Mix Asphalt - End Result
OPSS 350 Concrete Pavement and Concrete Base

Ontario Provincial Standard Specifications, Material

OPSS 1103 Emulsified Asphalt
OPSS 1350 Concrete - Materials and Production

Ontario Ministry of Transportation Publications

MTO Laboratory Testing Manual:
LS-100 Rounding-Off of Test Data and Other Numbers
LS-601 Material Finer Than 75 μm Sieve in Mineral Aggregates by Washing
LS-602 Sieve Analysis of Aggregates
LS-604 Relative Density and Absorption of Coarse Aggregate
LS-606 Soundness of Aggregates by Use of Magnesium Sulphate
LS-608 Per cent Flat and Elongated Particles in Coarse Aggregate
LS-614 Freezing and Thawing of Coarse Aggregates
LS-618 Resistance of Coarse Aggregate to Degradation by Abrasion in the Micro-Deval Apparatus
LS-625 Guidelines for Sampling of Granular Materials
LS-627 Open-Graded Drainage Layer (OGDL) Core Porosity Test
LS-630 Determination of Amount of Contamination of Coarse Aggregate
LS-631 Qualitative Determination of Presence of Plastic Fines in Aggregates

ASTM International

C174/C174M-17 Standard Test Method for Measuring Thickness of Concrete Elements Using Drilled Concrete Cores

320.03 DEFINITIONS

For the purpose of this specification, the definitions in OPSS 313 and OPSS 350 and the following definitions apply:

Delineator means the material used to delineate boundary between Portland cement treated open graded drainage layer and the overlying concrete slab to facilitate measurement of the slab thickness.

Open Graded Drainage Layer (OGDL) means a rapid draining layer located within the pavement structure that is covered either by concrete pavement, concrete base, or hot mix asphalt pavement and overlies the granular base course. The OGDL can be either Portland cement treated or asphalt cement treated.

Porosity of OGDL means the ratio of the volume of voids to total volume of OGDL as measured by LS-627.

Thickness means the thickness in millimetres of the OGDL lift as specified in the Contract Documents.

320.04 DESIGN AND SUBMISSION REQUIREMENTS

320.04.01 Submission Requirements

The following information shall be submitted to the Contract Administrator at least three Days prior to placement of the OGDL:

a) Source(s) for the OGDL aggregate material.

b) Volumetric proportions for the OGDL mixture.

c) The type of plant to be used for OGDL mixture production and the plant location.

320.05 MATERIALS

320.05.01 General

Proportioning and mixing of OGDL materials shall produce a uniform homogenous mixture in which all particles of the aggregates are thoroughly and uniformly coated.

The porosity of the placed OGDL lift shall be 0.250 to 0.400, determined according to LS-627.

320.05.02 Aggregates

Aggregates for OGDL shall consist of 100% crushed particles produced by crushing bedrock material. Reclaimed materials or crushed reclaimed materials shall not be used.

The aggregates shall meet all of the requirements for gradation and physical properties shown in Tables 1 and 2.

320.05.03 Asphalt Cement Treated OGDL

Asphalt cement shall be according to the requirements for performance graded asphalt cement specified in the Contract Documents. The per centage by mass of asphalt cement in the mixture shall be 1.8 ± 0.2%.

320.05.04 Portland Cement Treated OGDL

Cementing materials and water used in production of OGDL shall be according to OPSS 1350.

The mix shall contain 120 ± 10 kg/m^3 of Type GU Portland cement or Portland limestone cement (PLC) Type GUL. A portion of Portland or Portland limestone cement may be replaced by supplementary cementing materials as specified in OPSS 1350.

320.05.05 Delineator

The delineator shall consist of SS-1 emulsified asphalt according to OPSS 1103 diluted with an equal volume of water.

320.06 EQUIPMENT

320.06.01 Production Equipment

Portland cement treated OGDL mix shall be produced, mixed and delivered from a batching plant according to OPSS 1350.

320.06.02 Paving Equipment

Paving equipment shall not cause segregation of the material and shall place a uniform, homogeneous OGDL across the lane to the required grade and design lift thickness specified in the Contract Documents.

Paving equipment shall be self-propelled and capable of laying a consistent satisfactory mat that is true to the crossfall, profile, cross-section, and alignment specified in the Contract Documents.

320.06.03 Straight Edge

The straight edge shall be 3 m in length, metal, and have a level recessed in its upper edge parallel to the lower edge.

320.07 CONSTRUCTION

320.07.01 Operational Constraints

OGDL mixture shall not be placed in the rain and the ambient temperature at the time of mixture placement shall be above 2°C. Precautions shall be taken to protect placed plastic Portland cement treated OGDL from rain.

Traffic shall not be permitted on the OGDL with the exception of sampling equipment, equipment for the application of delineator, and the paving train during the placement of the overlying pavement.

Contamination of the OGDL by mud or other contaminants shall not be permitted.

All OGDL shall be covered with the overlying pavement within 30 Days following placement.

The subdrains and lateral outlets of the drainage system shall be operational prior to the placement of the OGDL.

320.07.02 Longitudinal and Transverse Joints

All joints shall be made to obtain a complete bond between the two OGDL edges and a smooth riding surface. Longitudinal and transverse joints shall be butt joints. The existing or previously placed OGDL edge shall be a straight clean vertical surface for the full depth of the OGDL. Where ramping or damage has occurred, trimming shall be required.

All dirt or other foreign material and all loose material shall be removed from all vertical surfaces. When matching a compacted joint, the depth of the uncompacted mat shall be set to allow for compaction.

320.07.03 Rolling

Rollers for compaction shall not be in vibration mode. Aggregate pick-up by the rollers shall be avoided. When water is used on the roller drums to prevent aggregate pick-up, free water shall not be allowed to fall onto the Portland cement treated OGDL surface.

320.07.04 Surface Tolerances

The surface shall be shaped and compacted so the finished surface does not deviate more than 10 mm from the grade and cross-section specified in the Contract Documents.

The surface tolerance shall be such that when tested with a 3 m straight edge placed in any direction on the surface except across the crown, there shall not be a gap greater than 5 mm between the bottom of the straight edge and the surface of the OGDL. Correction of the finished surface by grading or milling, or both, shall not be permitted.

320.07.05 Delineation

A delineator shall be placed on the Portland cement treated OGDL prior to placement of the overlying concrete pavement or concrete base.

The delineator shall be applied using self-propelled or towed pressure distributors capable of applying the product in a continuous and uniform manner over all of the OGDL to be overlaid.

320.07.06 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

320.08 QUALITY ASSURANCE

320.08.01 General

A laboratory designated by the Owner shall carry out acceptance testing.

The Owner shall be responsible for all costs associated with testing for QA purposes, unless otherwise specified in this specification.

All test results shall be forwarded to the Contractor as they become available.

320.08.02 Sampling

The Contract Administrator shall be allowed access to all sampling locations and reserves the right to request a sample at any time.

All samples shall be placed in clean sample bags, then sealed and labelled, as specified in the Contract Documents.

All samples shall be accompanied by MTO Form PH-D-10.

320.08.02.01 Sampling of Aggregate for Gradation and Physical Properties

All aggregates samples shall be duplicate samples.

At least one duplicate 25 kg sample of aggregate from every lot of 50,000 m^2 or part thereof of OGDL being produced shall be obtained.

Additional samples shall also be taken whenever the aggregate changes to a new source or a new bench in a quarry or whenever a significant change in aggregate production or material occurs that may affect the quality of the material. In this case, the existing lot shall be terminated and a new lot commenced.

Unless otherwise specified, all samples of aggregate shall be taken at the plant producing OGDL from individual stockpiles with a minimum quantity of 500 tonnes of aggregate, or at least 10% of the total quantity of aggregate requirement for the OGDL mix, unless otherwise directed by the Contract Administrator.

Sampling from stockpiles shall be according to LS-625. Each sample shall be treated as discrete sample and not combined or blended with any other sample.

320.08.02.02 Sampling of OGDL for Thickness and Porosity

The Contract Administrator shall establish the lot size as well as the number of sublots for thickness and porosity sampling, after discussions with the Contractor and prior to placement of the OGDL.

Lot size is generally 40,000 m^2 with the sublot size of 4,000 m^2. In all cases, a maximum allowable sublot numbers is 10 sublots per lot.

Within five Business Days of placement and prior to the placement of the overlying pavement layer, one intact 150 mm nominal diameter core shall be taken of the full depth of the OGDL for each sublot at a random location selected by the Contract Administrator.

Metal or cardboard containers that protect the integrity and shape of cores during transportation and until testing shall be used. When cores are taken the cores shall be intact and undamaged. If an intact and undamaged core cannot be obtained, then the sample shall be taken by saw cutting an intact sample with minimum dimensions of 140 by 140 mm square and maximum dimensions of 145 by 145 mm square. The sample shall be delivered intact and undamaged.

Immediately after sampling, each sample hole shall be filled with OGDL aggregate, treated with asphalt cement or Portland cement, up to the top of the surrounding OGDL.

320.08.03 Testing

320.08.03.01 Gradation and Physical Properties

Aggregates shall be tested according to Tables 1 and 2.

Aggregate shall be tested according to LS-614, unless written notification to the Contract Administrator to test according to LS-606 is received prior to sampling of the applicable materials for QA purposes. Unless the Contract Administrator has received such a request to replace LS-614 with LS-606, conformance to LS-614 shall be required.

When notification to replace LS-614 is received after QA testing using LS-614 has been initiated, the cost of the testing using LS-614, administrative charges, and additional sampling, if required, shall be paid by the Contractor.

320.08.03.02 Thickness

One sample from each sublot shall be tested to determine the thickness of the OGDL according to ASTM C174. The test result for each sublot shall be used to compute the lot mean thickness calculated to one decimal place according to LS-100.

320.08.03.03 Porosity

The same sample used for the thickness determination from each sublot shall be tested to determine the porosity of the OGDL according to LS-627. The test result for each sublot shall be used to compute the lot mean porosity calculated to two decimal places according to LS-100.

320.08.04 Acceptance

Acceptance of OGDL shall be based on the gradation and physical properties of the aggregates used as well as the thickness, porosity, surface appearance and surface tolerance of the OGDL after placement.

320.08.04.01 Acceptance of Gradation and Physical Properties

The aggregates within a lot of OGDL shall be deemed to be acceptable, if the test results for the aggregate sample representing that lot meet all of the acceptance limit requirements specified in Tables 1 and 2.

If one or more test results for an aggregate sample representing a lot of OGDL do not meet all of those acceptance limit requirements, then the OGDL aggregates shall be removed from the Work and replaced according to the Repairing and Re-Decisioning subsection, or a price reduction applied at the discretion of the Contract Administrator. A price reduction may only be applied for each m^2 of OGDL left in the Work as long as the aggregate sample representing that lot are all within the price reduction range(s) specified in Tables 1 and 2.

If the QA test results of an aggregate sample representing a lot of OGDL for gradation and physical properties do not meet all the specified requirements and are not price adjusted, then all of the aggregates within that lot shall be rejected and any OGDL that includes those aggregates shall be removed from the Work and replaced at no additional cost to the Owner .

320.08.04.02 Acceptance of Surface Appearance

The surface appearance of the OGDL shall be assessed by the Contract Administrator based on visual surveys. The finished OGDL surface shall have a uniformly open texture and be free of loose aggregate. The OGDL shall be rejectable if:

a) A single appearance of irregularity exceeds 5 m^2.

b) The combined area of multiple irregularities exceeds 10 m^2 over a 100 m^2 section.

c) Any OGDL identified by the Contract Administrator as being contaminated.

OGDL that is rejected for its appearance shall be repaired. OGDL that is repaired shall be re-decisioned according to the Repairing and Re-Decisioning subsection.

320.08.04.03 Acceptance of Surface Tolerance

All areas not meeting the surface tolerance requirements as specified in the Surface Tolerances subsection shall be rejected and repaired and re-decisioned according to the Repairing and Re-Decisioning subsection.

320.08.04.04 Acceptance of Thickness

Thickness acceptance shall be based on the mean of the lot, provided that no single sublot is deemed rejectable. A sublot shall be rejected, if the sublot thickness is less than 0.60 of the design lift thickness. Rejected sublots shall not be included in the lot mean thickness calculation.

If the lot mean thickness is greater than or equal to the design lift thickness, the item shall be accepted without any price reduction for thickness.

If the lot mean thickness is less than the design lift thickness, but greater than or equal to 0.75 of the design lift thickness, the lot shall be subject to a price reduction calculated using the pay factors given in Table 3.

The lot shall be rejected, if the lot mean thickness is less than 0.75 of the design lift thickness.

If repair to the lot is chosen in lieu of a price reduction or if a rejected lot requires repair, the lot shall be repaired and decisioned according to the Repairing and Re-Decisioning subsection.

320.08.04.05 Acceptance of Porosity

Acceptance for the porosity of OGDL shall be based on the lot mean for the porosity of OGDL, and the porosity of individual sublots.

A sublot shall be rejected if the porosity of OGDL is less than 0.200 or greater than 0.500. Rejected sublots shall not be included in the lot mean porosity calculation and shall be repaired according to the Repairing and Re-Decisioning subsection.

The lot shall be accepted if the lot mean porosity of OGDL is greater than or equal to 0.25, and less than or equal to 0.40, and with less than 30% of sublots with porosity outside the range of 0.250 to 0.400.

If the lot mean porosity of OGDL is greater than or equal to 0.25, and less than and equal to 0.40, and with more than 30% of sublots with porosity outside the range of 0.250 to 0.400, those sublots outside the range shall require repair until more than 30% of sublots are within the range of 0.250 to 0.400 for the porosity.

If the lot mean porosity of OGDL is greater than or equal to 0.20 and less than 0.25, or greater than 0.40 and less than and equal to 0.50, the lot shall be subjected to a price reduction calculated using the pay factors in Table 4. If the Contractor elects to repair the sublots in lieu of a payment adjustment, the sublots shall be repaired and re-decisioned according to the Repairing and Re-Decisioning subsection.

If the lot mean porosity of OGDL is less than 0.20 or greater than 0.50, the lot shall be rejected, repaired and re-decisioned according to the Repairing and Re-Decisioning subsection.

320.08.04.06 Referee Testing for Gradation and Physical Properties

Referee testing may be invoked for one or more attributes by submitting a written request to the Contract Administrator, within five Business Days following notification that a sample representing a lot of OGDL does not meet the requirements of this specification.

Referee testing shall be carried out, as specified herein as specified in the Contract Documents.

The retained duplicate QA aggregates samples shall be used for referee testing.

All referee test results for a lot shall replace the respective QA tests for acceptance of the applicable lot and shall be binding on both the Owner and the Contractor.

If a lot is not accepted at full payment based on the referee test results, the cost of the referee testing of that lot, including the cost of transporting the samples to the referee laboratory, at the rates as specified in the Contract Documents shall be at no addition cost to the Owner. In all other cases, the Owner shall bear the cost of the referee testing and the cost of transporting the samples of that lot.

320.08.04.07 Re-test for Thickness and Porosity

Re-testing for thickness or porosity or both may be invoked by submitting a written request to the Contract Administrator, within five Business Days following notification that any QA samples representing a lot or sublot of OGDL fails to meet the requirements of this specification.

The re-test shall be carried out on the same QA sample, as specified herein and elsewhere as specified in the Contract Documents.

Witnessing of the re-test of the same QA samples for thickness and porosity is permitted.

All re-test results for a lot or sublot shall replace the respective QA tests for acceptance of the applicable lot or sublot and shall be binding on both the Owner and the Contractor.

If a lot is not accepted at full payment based on the re-test results, the cost of the re-testing of that lot shall be at no addition cost to the Owner. In all other cases, the Owner shall bear the cost of the re-testing.

320.08.05 Repairing and Re-Decisioning

320.08.05.01 General

All repairs including remove and replace to OGDL shall be full lane or shoulder width and a sufficient length for the repair to be carried out employing the same equipment used during initial placement of the OGDL with the exception of repairs for surface deficiencies in surface tolerance. OGDL used for repairs shall meet the requirements of this specification.

All repairs shall be carried out at no additional cost to the Owner.

320.08.05.02 Gradation and Physical Properties

Any OGDL that includes rejected aggregates, as specified in the Acceptance of Gradation and Physical Properties clause, shall be removed and replaced.

320.08.05.03 Surface Appearance

Rejected OGDL due to surface irregularities or contamination shall be removed and replaced.

320.08.05.04 Surface Tolerance

Where the finish grade of OGDL is below the design grade, the final grade of the pavement shall be corrected with an additional thickness of overlying surface material. Patching on the surface of OGDL shall not be permitted. If the finish grade of OGDL is above the design grade, the overlying surface material shall follow the design thickness. Milling on the surface of OGDL shall not be permitted.

320.08.05.05 Thickness and Porosity

For each sublot or lot that is rejected due to thickness or porosity or both or chosen for repair, the entire sublot of OGDL shall be removed and replaced.

When removal and replacement are made to rejectable sublots or those sublots that are chosen for repair due to non-compliance, the original lot and replaced sublots shall be re-evaluated and re-decisioned for acceptance.

The original lot shall be divided into two reconfigured lots in the following way: All non-replaced sublots shall be grouped as one lot; the remaining sublots (i.e., replaced sublots) shall be grouped as another lot. Lot mean thickness and lot mean porosity shall be re-calculated for both reconfigured lots and shall be re-decisioned for either in payment at the full Contract price, subjected to a payment reduction, or deemed rejectable.

320.09 MEASUREMENT FOR PAYMENT

320.09.01 Actual Measurement

320.09.01.01 Open Graded Drainage Layer

Measurement of OGDL shall be by area in square metres.

320.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clause under Actual Measurement.

320.10 BASIS OF PAYMENT

320.10.01 Open Graded Drainage Layer - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work, except as otherwise specified herein.

When test results show that either the thickness payment factor or porosity of OGDL payment factor for the lot is less than 1.000, the payment reduction for the lot shall be as follows.

$$(2.000 - PF_T - PF_P) \times \text{item price} \times \text{lot quantity}$$

Where: PF_T and PF_P are calculated according to Table 3 and 4, respectively.

In addition, any OGDL that contains aggregates that do not meet any of the requirements for gradation or physical properties as specified in the Acceptance of Gradation and Physical Properties clause shall be subjected to a 10% payment reduction.

For purposes of payment reduction, the term item price means the Contract price of the Open Graded Drainage Layer item.

TABLE 1
Gradation Requirements (LS-602)

Per centage Passing By Mass of Aggregate (Note 1)		
Sieve Designation	**Acceptance Limit**	**Price Reduction Range(s)**
37.5 mm	100.0	90.1 – 100.0
26.5 mm	95.0 – 100.0	85.5 – 94.9
19.0 mm	90.0 – 100.0	81.0 – 89.9
16.0 mm	65.0 – 100.0	58.5 – 64.9
13.2 mm	40.0 – 86.0	36.0 – 39.9 **or** 86.1 – 94.6
9.5 mm	20.0 – 55.0	18.0 – 19.9 **or** 55.1 – 60.5
4.75 mm	0.0 – 10.0	10.1 – 12.0
2.36 mm	0.0 – 5.0	5.1 – 6.0
75 μm	0.0 – 2.0	2.1 – 2.4
Notes: 1. All results are rounded to one decimal place according to LS-100.		

TABLE 2
Physical Property Requirements

MTO Test Number	Laboratory Test	Acceptance Limit	Price Reduction Range
LS-601	Wash Pass 75μm sieve, Guideline B, % maximum	2.0	2.1 - 2.2
LS-604	Absorption, % maximum	2.0	2.1 - 2.2
LS-608	Flat and Elongated Particles, % maximum (4:1)	20.0	20.1 - 22.0
LS-614	Unconfined Freeze-Thaw, % maximum loss (Note 1)	15.0	15.1 - 18.8
LS-618	Micro-Deval Abrasion, % maximum loss	21.0	21.1 - 23.1
LS-630	Amount of Contamination, % maximum	1.0 (Note 2)	≤1.1 (Note 2)
LS-631	Plastic Fines	NP (Non-Plastic)	NP (Non-Plastic)
Alternative Requirement for LS-614			
LS-606	Magnesium Sulphate Soundness, % maximum loss (Note 1)	15.0	15.1 - 18.8

Notes:

1. The Owner shall waive the requirements for LS-614, Unconfined Freeze-Thaw, provided the Contractor has submitted a written request that the aggregate meet the alternative requirements for LS-606, Magnesium Sulphate Soundness.
2. Combined amount of wood, clay brick (CONSIDER CHANGING TO xxx and xxx, xxx or xxx, xxx or xxx or both) gypsum (CONSIDER CHANGING TO xxx and xxx, xxx or xxx, xxx or xxx or both) gypsum wall board or plaster, etc. shall not exceed the maximum per centages by mass shown above.
3. All results are rounded to one decimal place according to LS-100.

TABLE 3
Thickness Payment Factors

Acceptance Criteria	Classification	Payment Factor, PF_T
$T_C \geq T_D$	Acceptable	1.000
$0.9T_D \leq T_C < 1.0T_D$	Payment Reduction	T_C/T_D
$0.75T_D \leq T_C < 0.9T_D$	Payment Reduction	$(T_C/T_D)^{1.5}$

Where:

T_D is the OGDL design lift thickness specified in the Contract Documents in millimetres.

T_C is the mean thickness of OGDL of the lot in millimetres calculated to one decimal place according to LS-100.

PF_T is the payment factor for thickness of the OGDL of the lot calculated to three decimal places according to LS-100.

TABLE 4
Porosity of OGDL Payment Factors

Acceptance Criteria	Classification	Payment Factor, PF_P
$0.25 \leq n_c \leq 0.40$ with **less** than 30% of sublots with porosity outside the range of 0.250 to 0.400	Acceptable	1.000
$0.20 \leq n_c < 0.25$	Payment Reduction	$1 - 4(0.25 - n_c)$
$0.40 < n_c \leq 0.50$	Payment Reduction	$1 - 2(n_c - 0.40)$

Where:

PF_P is the payment factor for porosity of OGDL of the lot calculated to three decimal places according to LS-100.

n_c is the mean porosity of OGDL of the lot calculated to two decimal places according to LS-100.

Appendix 320-A, November 2020
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- The requirements for performance graded asphalt cement. (320.05.03)

- Supplementary cementing materials. (320.05.04)

- Sealing and labelling. (320.08.02)

- Referee testing. (320.08.04.06)

- Re-testing. (320.08.04.07)

GENERAL:
Open Graded Drainage Layer (OGDL) is a highly permeable layer which is covered by a concrete pavement, concrete base or a hot mix asphalt pavement, and overlies a granular base course.

The design of all composite and concrete pavements should use an OGDL. OGDLs should be reviewed for use on all major arterial and expressway projects with composite and concrete pavements and may be considered for deep strength flexible pavements.

The thickness of the OGDL should be 100 mm. The unit weight of OGDL is 1.7 t/m^3. The OGDL is assigned the same structural value as a granular base.

DESIGN:
OGDL shall be drained by an edgedrain collector system, such as a conventional pipe subdrain backfilled with OGDL aggregate, wrapped in geotextile, which is in direct contact with the OGDL.

DOCUMENTATION:
OGDL locations are documented by station to station limits on Quantities - Hot Mix and Granular quantity sheet(s). The calculated square metre quantity is entered in the appropriate column.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 207.041	Open Graded Drainage Layer with Subdrain Pipe, Paved Shoulders
OPSD 207.044	Subdrain Pipe Connections and Outlets, for Open Graded Drainage Layer

CONSTRUCTION SPECIFICATION FOR IN-PLACE FULL DEPTH RECLAMATION OF BITUMINOUS PAVEMENT AND UNDERLYING GRANULAR

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330-A **Commentary**

330.01 SCOPE

This specification covers the requirements for in-place full depth reclamation of bituminous pavement and mixing with a portion of the underlying granular, and shaping and compacting the processed materials as granular base.

330.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

330.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

330.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 301 Restoring Unpaved Roadway Surfaces
OPSS 501 Compacting

Ontario Ministry of Transportation Publications

MTO Laboratory Testing Manual:
LS-621 Determination of Amount of Asphalt-Coated Particles in Coarse Aggregate

330.07 CONSTRUCTION

330.07.01 General

The work of in-place full depth reclamation shall consist of pulverizing the existing bituminous pavement, mixing the processed material with the underlying granular material, and shaping and compacting the blended material and the existing shoulders.

330.07.02 Operational Constraints

The in-place full depth reclamation including pulverizing, mixing, shaping, and compacting to final grade shall be completed across the full pavement width prior to closing down operations each day.

The existing shoulders shall also be shaped and compacted to grade prior to closing down operations each day.

330.07.03 Reclamation of Bituminous Pavement and Underlying Granular

The bituminous pavement and underlying granular shall be reclaimed to the depths specified in the Contract Documents. The tolerance for the average depth of processing shall be ± 15 mm from the depth specified.

The processed depth shall be such that the blended material shall contain a maximum of 50% by mass of asphalt coated aggregate in the final blend as determined by LS-621.

The operation of full-depth reclamation shall ensure that 100% of the mixed material by mass passes the 50 mm sieve and 95% passes the 37.5 mm sieve.

330.07.04 Surface Shaping and Compacting

The graded surface of the processed material, including existing shoulder, shall be according to the requirements of OPSS 301. The material shall be compacted as specified in OPSS 501. Scarifying and fine grading to the specified lines and grades shall be carried out immediately prior to paving.

330.07.05 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

330.08 QUALITY ASSURANCE

330.08.01 Samples for Testing

Samples for testing may be taken by the Contract Administrator to ensure that the mix is according to LS-621.

330.09 MEASUREMENT FOR PAYMENT

330.09.01 Actual Measurement

330.09.01.01 In-Place Full Depth Reclamation of Bituminous Pavement and Underlying Granular

Measurement of in-place full depth reclamation of bituminous pavement and underlying granular shall be by horizontal area processed in square metres.

330.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

330.10 BASIS OF PAYMENT

330.10.01 In-Place Full Depth Reclamation of Bituminous Pavement and Underlying Granular - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

Appendix 330-A, November 2014
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Reclamation depth of bituminous pavement and underlying granular. (330.07.03)

When additional granular base material is specified, it should be placed prior to the full depth reclamation and incorporated into the processed material.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

CONSTRUCTION SPECIFICATION FOR FULL DEPTH RECLAMATION WITH EXPANDED ASPHALT STABILIZATION

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APPENDICES

331-A Commentary

331.01 SCOPE

This specification covers the requirements for in-place full-depth reclamation of the existing hot mix asphalt (HMA) pavement and underlying granular base; shaping and compacting the unstabilized material; adding and blending corrective aggregate or active filler or both, if required; adding and mixing expanded asphalt; and shaping and compacting the expanded asphalt mix.

331.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

331.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

331.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, and publications:

Ontario Provincial Standard Specifications, Construction

OPSS 301 Restoring Unpaved Roadway Surfaces
OPSS 310 Hot Mix Asphalt
OPSS 501 Compacting

Ontario Provincial Standard Specifications, Material

OPSS 1010 Aggregates - Base, Subbase, Select Subgrade, and Backfill Material
OPSS 1101 Performance Graded Asphalt Cement
OPSS 1301 Cementing Materials

Ontario Ministry of Transportation Publications

SP-027 Manual for Assessment of Surface Defects of In-Place Recycled Pavement Mats

MTO Laboratory Testing Manual:
LS-200 Penetration of Bituminous Materials
LS-282 Quantitative Extraction of Asphalt Cement and Analysis of Extracted Aggregate from Bituminous Paving Mixtures
LS-292 Quantitative Determination of Asphalt Cement Content by Ignition and Analysis of Remaining Aggregate from Bituminous Paving Mixtures
LS-297 Determination of Indirect Tensile Strength of Expanded Asphalt Mixes
LS-625 Sampling of Granular Materials

Ontario Traffic Manual (OTM):
Book 7 - Temporary Conditions

Wirtgen GmbH Publication

Wirtgen Cold Recycling Technology manual, 3rd edition, 2010

331.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Active Filler means substances added to the reclaimed materials that chemically alter the mix properties.

AMRL means as defined in OPSS 310.

CCIL means as defined in OPSS 310.

Corrective Aggregate means virgin aggregate or reclaimed asphalt pavement (RAP) or both added to the reclaimed materials to meet the expanded asphalt mix requirements.

Expanded Asphalt means heated asphalt cement expanded from its normal volume by the addition of water.

Expanded Asphalt Mix (EAM) means the mixture of reclaimed materials; corrective aggregate or active filler or both, if required; and expanded asphalt.

Performance Graded Asphalt Cement (PGAC) means as defined in OPSS 310.

Quality Assurance (QA) means as defined in OPSS 310.

Quality Control (QC) means as defined in OPSS 310.

Reclaimed Asphalt Pavement (RAP) means as defined in OPSS 310.

Unstabilized Material means the mixture of reclaimed existing asphalt pavement and granular base and corrective aggregate or active filler or both, if required.

331.04 DESIGN AND SUBMISSION REQUIREMENTS

331.04.01 Design Requirements

For mix design purposes, prior to commencing the work the Contractor shall obtain samples representative of the material that is produced during in-place full-depth reclamation. These samples shall be used to establish the design rate of expanded asphalt as a per cent by mass of the unstabilized material. The design rate of the expanded asphalt shall be a minimum of 2.8%. The dry tensile strength shall be a minimum of 225 kPa and the wet tensile strength shall be a minimum of 100 kPa. The tensile strength ratio shall be a minimum of 50%.

The mix design shall be carried out according to the Wirtgen Cold Recycling Technology manual using briquettes produced according to LS-297. Mix design work shall be completed by a laboratory with CCIL Type A certification or equivalent equipped to carry out expanded asphalt mix design. When the existing pavement significantly changes composition, a separate mix design shall be completed.

Each mix design shall include the following

a) Information on the grade, manufacturer, and supplier of the PGAC.

b) The per cent by mass of expanded asphalt in the mix, referred to as the design rate, and all calculations performed to determine the design rate of the expanded asphalt.

c) The recommended PGAC temperature for foaming, the half life, the expansion ratio, and the per cent water added for foaming.

d) The optimum moisture content and the mix design bulk relative density.

e) The dry tensile strength, the wet tensile strength, and the tensile strength ratio.

f) The amount of water to be added to the mix.

g) Maximum field rate adjustment allowed to the design rate without adverse affects to mix properties.

h) Recovered penetration for the binder of the existing pavement according to LS-200.

i) Type, source, gradation, and quantity of corrective aggregate, if required.

j) Type, source, and quantity of active filler, if required.

331.04.02 Submission Requirements

The mix design shall be submitted by the Contractor to the Contract Administrator a minimum of 7 Business Days prior to the start of the reclamation and stabilization. When more than one mix design is required, the area for which each mix design is to be used shall be clearly identified.

A new mix design shall be submitted when the expanded asphalt design rate is adjusted by 0.3% or greater. Separate or new mix designs shall be submitted if the composition or layer thicknesses or both of the existing pavement changes significantly.

331.05 MATERIALS

331.05.01 Active Filler

If required by the mix design, active filler shall be incorporated into the reclaimed material at the application rate determined in the mix design.

When used as active filler, Portland cement shall be according to OPSS 1301. No more than one per cent by mass of Portland cement shall be added to the mix.

331.05.02 Corrective Aggregate

If required by the mix design, corrective aggregate shall be incorporated into the reclaimed material at the application rate determined in the mix design. Corrective aggregate shall meet the physical property requirements of OPSS 1010 for Granular A.

331.05.03 Performance Graded Asphalt Cement

The Contractor shall select a PGAC with suitable expansion characteristics. PGAC shall be according to OPSS 1101, excluding the PGAC zone requirements.

331.05.04 Reclaimed Asphalt Pavement

RAP material shall be 100% passing the 37.5 mm sieve and 95 to 100% passing the 26.5 mm sieve after processing.

331.05.05 Water

Water shall be clean and free from oil, acid, alkali, organic matter, or other deleterious substances.

331.06 EQUIPMENT

331.06.01 Full-Depth Reclamation and Stabilization Equipment

The reclaimer-stabilizer shall be capable of reclaiming the existing asphalt pavement and underlying granular base to the depths specified in the Contract Documents, incorporating corrective aggregate or active filler or both into the mix, adding expanded asphalt in a controlled manner, and producing a uniform mix.

The reclaimer-stabilizer shall be fitted with an automatic sensor system to accurately maintain a preset depth of cut within a tolerance of 10 mm and shall have a minimum 2.0 m wide cutting drum.

The reclaimer-stabilizer shall have an asphalt cement expansion system capable of producing optimum expansion and an injection system capable of injecting and blending expanded asphalt uniformly throughout the unstabilized material. In order to mix the unstabilized material with the expanded asphalt, the reclaimer-stabilizer shall include the following features:

a) A system to control and regulate the application of expanded asphalt in relation to travel speed and mass of material within a tolerance of $\pm$ 3.0% by volume of asphalt cement.

b) A system to monitor and control all aspects of the mixing process, including per cent expanded asphalt, rate of application, and per cent water for optimum compaction.

c) A system of nozzles that provides uniform application of the expanded asphalt across the full width of treatment. The application system shall be adjustable for varying widths of treatment.

The aggregate delivery vehicle shall have a system for controlled application of the corrective aggregate.

Alternative equipment may be considered subject to approval by the Contract Administrator and demonstration of meeting the requirements of the Expanded Asphalt Trial Section subsection.

331.06.02 Placing Equipment

Placing of the expanded asphalt mix shall be carried out by means of a self-propelled mechanical paver capable of spreading the mix evenly in front of the screed in one continuous pass to the specified cross-fall and grade. The paver shall be equipped with distributing augers for the full width to be paved. The paver shall have a vibratory screed capable of vibrating the full width of mix placed.

331.06.03 Pilot Vehicle

The pilot vehicle shall be according to the requirements of the OTM, Book 7.

331.07 CONSTRUCTION

331.07.01 Operational Constraints

In-place full depth reclamation, including mixing, shaping, and compacting to final grade, shall be completed across the full pavement width prior to closing down operations each day.

The existing shoulders shall be shaped and compacted to match the adjacent lane prior to closing down operations each day.

Expanded asphalt stabilization shall not proceed during periods of rain or when the surface is in a saturated condition.

Traffic, including construction traffic, shall be kept off the freshly placed EAM until such time as it is able to carry traffic without damage. The Contractor shall be responsible for repair of damaged EAM.

The wearing surface shall not be placed on the EAM until the following requirements have been met:

a) The EAM has been allowed to cure for a minimum of 2 Days.

b) The Contractor has demonstrated that the EAM meets all the requirements of this specification.

c) All defective areas in the EAM have been repaired to the satisfaction of the Contract Administrator.

331.07.02 In-Place Full-Depth Reclamation

The existing asphalt pavement and underlying granular base shall be reclaimed to the depths and widths specified in the Contract Documents.

The graded surface of the reclaimed material, including existing shoulders, shall be according to the surface tolerance requirements of OPSS 301. Reclaimed material exceeding 50 mm in size shall be removed from the work. The material shall be compacted according to OPSS 501.

331.07.03 Expanded Asphalt Trial Section

Prior to carrying out expanded asphalt stabilization on the Contract, the Contractor shall demonstrate to the Contract Administrator the ability to successfully carry out expanded asphalt stabilization according to this specification by placing a trial section within the Contract limits.

In lieu of a trial section, the Contract Administrator may accept evidence that the Contractor has demonstrated the ability to successfully mix, handle, place, and compact EAM with the same equipment, placing crew, and methodology to meet the Contract requirements for placing EAM on any Contract within the last 12 months.

The trial section shall be a minimum of 3,500 m^2 or the equivalent of one tanker load of asphalt cement. The Contractor shall propose the location of the trial section to the Contract Administrator for approval. The Contractor shall give the Contract Administrator a minimum of 48 hours notice prior to placing the trial section.

The Contract Administrator shall allow the Contractor to continue the expanded asphalt stabilization work based on an acceptable visual assessment of the trial section according to the requirements of the Grading and Compacting the Expanded Asphalt Mix subsection. When EAM is rejected by visual assessment, the Contractor shall repeat additional trial sections until the EAM meets the requirements of this specification.

The Contractor shall be responsible for the repair, removal, or replacement of an unacceptable trial section.

331.07.04 Expanded Asphalt Stabilization

The Contractor shall stabilize to the depth and limits detailed in the Contract Documents. The overlap between successive passes of the reclaimer-stabilizer shall be a minimum of 100 mm and a maximum of 150 mm.

If required, corrective aggregate or active filler or both shall be added to the roadway prior to stabilizing.

In areas that are inaccessible to the reclaimer-stabilizer equipment, existing asphalt pavement shall be removed and replaced with a minimum 100 mm of binder course hot mix placed flush with the adjacent EAM surface.

331.07.05 Grading and Compacting the Expanded Asphalt Mix

The material shall be compacted to a minimum 97% of the target density, as determined in OPSS 501 for granular materials.

The compacted surface of the EAM shall be according to the surface tolerances specified in OPSS 301. Regrading of the EAM to correct crossfall deficiencies shall be minimized.

The compacted surface of the EAM shall be uniform in texture and free of segregation, longitudinal streaks, flushing, fat spots, oil spills, roller marks, and other surface defects.

331.07.06 Sampling

The Contractor shall be responsible for all sampling.

331.07.06.01 Corrective Aggregate

The Contract Administrator may request samples of the corrective aggregate to demonstrate conformance to the requirements of this specification. When requested, two 25 kg samples shall be taken in the presence of the Contract Administrator.

QA samples shall be taken in accordance with procedures given in LS-625 and at the time and location determined by the Contract Administrator.

Samples of corrective aggregate shall be obtained, properly labelled and identified, and delivered within 48 hours of sampling to the designated QA testing laboratory as specified in the Contract Documents.

331.07.06.02 Active Filler

The Contract Administrator may request samples of active filler to demonstrate conformance to the requirements of this specification.

331.07.06.03 Expanded Asphalt Mix

Samples of unstabilized material and EAM shall be taken at a minimum frequency of one set of samples per 5,000 m^2. To obtain a set of samples, the Contractor shall take one 15 kg sample of unstabilized material immediately following in-place full depth reclamation and from the same approximate location a second 15 kg sample of EAM, immediately following stabilization. The maximum sampling depth shall be 100 mm. The second sample may be obtained after placement and prior to compaction.

The samples shall be packaged in a non-absorptive material to protect sample integrity, sealed in waterproof containers, appropriately labelled, and delivered by the Contractor in good condition within 48 hours of sampling to the designated QA testing laboratory specified in the Contract Documents.

331.07.07 Traffic Convoy

When specified in the Contract Documents, the Contractor shall convoy traffic according to the OTM, Book 7.

The pilot vehicle shall guide one-way traffic through or around construction. The maximum speed of the convoy shall be 30 km/h. Convoying shall be maintained until such time as the expanded asphalt stabilized mat is able to carry traffic without damage.

331.07.08 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

331.08 QUALITY ASSURANCE

331.08.01 General

Acceptance shall be based on QA testing. QA testing shall be carried out by a laboratory currently certified by CCIL with Type A or Type B certification or AMRL accredited or equivalent laboratory.

Acceptance criteria shall be based on the QA test results for each 5,000 m^2 placed.

All unacceptable material and all unacceptable surface deficiencies, mix, or work shall be rejected. Defective material, mixture, and work shall not be incorporated into the finished work.

331.08.02 Acceptance of Corrective Aggregate

QA testing may be carried out to ensure that corrective aggregate to be used in the work is according to the physical property requirements of Granular A according to OPSS 1010.

331.08.03 Acceptance of the Expanded Asphalt Mix

331.08.03.01 Surface Appearance

Surface appearance shall be assessed by the Contract Administrator based on SP-027 manual after the EAM mat has been opened to traffic. The finished EAM surface shall have a uniformly smooth texture and be free from surface defects of ravelling, deformation, flushing, and rutting prior to placement of the HMA overlay.

331.08.03.02 Asphalt Cement Content

The sample of unstabilized material taken immediately following in-place full depth reclamation and the sample of EAM taken immediately after stabilization shall be tested for total asphalt cement content in accordance with LS-282 or LS-292. The total asphalt cement content of the EAM includes existing aged asphalt cement and new asphalt cement. The per cent by mass of new asphalt cement added to the unstabilized material shall be determined from the two samples at each location by subtracting the total asphalt cement content of the unstabilized material from the total asphalt cement content of the EAM.

The average new asphalt cement content of each 5,000 m^2 placed shall not be less than 0.4% or more than 0.6% of the established mix design.

331.08.03.03 Tensile Strength

Samples of EAM shall also be tested for dry tensile strength, wet tensile strength, and tensile strength ratio according to LS-297.

Dry tensile strength requirements for the sample are met when the dry tensile strength of the sample is equal to or greater than the minimum requirement of 225 kPa.

Wet tensile strength requirements for the sample are met when wet tensile strength of the sample is equal to or greater than the minimum requirement of 100 kPa.

The tensile strength ratio for the sample shall not be less than 50%.

331.08.04 Acceptance of Thickness

Thickness of the EAM shall be measured by the Contract Administrator. Measurements shall be taken by excavating along the edge of the stabilized pass with a shovel and measuring the depth of stabilization from the bottom of the EAM to the surface of the adjacent unstabilized material. Thickness requirements for each 5,000 m^2 are met when the following are satisfied:

a) At least 90% of all thickness measurements for each 5,000 m^2 are equal to or greater than the specified thickness minus 20 mm.

b) No individual thickness measurement for each 5,000 m^2 is less than the specified thickness minus 30 mm.

331.08.05 Acceptance of Compaction

Compaction measurements shall be taken by the Contract Administrator according to OPSS 501 for granular materials. Compaction requirements of the EAM placed are met when the following are satisfied:

a) The average of all compaction measurements for each 5,000 m^2 is greater than or equal to 97% of the target density.

b) No individual compaction measurement for each 5,000 m^2 is less than 95% of the target density.

331.08.06 Repairing and Re-Decisioning

With the exception of repairs for surface tolerance, the minimum width of repair shall be the full width of the reclaimer-stabilizer equipment, the minimum length shall be sufficient for the repair to be carried out, and all repairs shall be made using the same equipment as was used during initial production and placement.

To meet the specified surface tolerance, all deficient areas shall be re-profiled by grading or padding or padded with the same HMA type to be used in the overlying HMA lift.

Unacceptable EAM, including any area damaged or contaminated by traffic or by natural or added water shall be reprocessed and, if required, additional expanded asphalt added. Alternatively, the Contractor shall remove and replace damaged or otherwise unacceptable EAM with the same hot mix type to be used in the overlying hot mix lift to a minimum depth of 50 mm according to OPSS 310.

Mixes that cannot be compacted to the specified density shall be removed to a minimum depth of 50 mm and replaced by an appropriate HMA approved by the Contract Administrator. When it is determined that the compaction cannot be achieved due to poor subgrade conditions, the Owner shall be responsible for the cost of repairs.

331.09 MEASUREMENT FOR PAYMENT

331.09.01 Actual Measurement

331.09.01.01 Full-Depth Reclamation with Expanded Asphalt Stabilization

Full-depth reclamation with expanded asphalt stabilization shall be measured for payment by horizontal area in square metres.

331.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

331.10 BASIS OF PAYMENT

331.10.01 Full-Depth Reclamation with Expanded Asphalt Stabilization - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

The addition of corrective aggregate or active filler to the mix shall be at no extra cost to the Owner.

PGAC shall be included in the Full-Depth Reclamation with Expanded Asphalt Stabilization item.

Repair of unacceptable EAM shall be carried out at no extra cost to the Owner.

Repair of areas of EAM damaged by traffic shall be completed at no extra cost to the Owner.

Repair, removal, or replacement of an unacceptable trial section shall be completed at no extra cost to the Owner.

Appendix 331-A, November 2016
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- The depths and widths for reclaiming existing asphalt pavement and underlying granular base. (331.07.02)

- The depth and limits of expanded asphalt stabilization. (331.07.04)

The designer should determine if the following is required and, if so, specify it in the Contract Documents:

- Traffic convoy requirements. (331.07.07)

Expanded asphalt mix (EAM) is a reclaimed asphalt pavement and granular base stabilized in-place by the addition of expanded asphalt and, if required, corrective aggregate and active filler.

EAM is a bound material and does not exhibit the same drainage characteristics as granular base material.

Expanded or "foamed" asphalt is created by injecting a carefully metered amount of cold water into hot asphalt cement in the mixing chamber of a pulverizer-stabilizer. The asphalt expands, reducing the viscosity of the asphalt cement and allowing easier dispersion throughout the mix.

The expanded asphalt bonds most effectively with finer aggregate particles forming a mortar to bond the coarser aggregate particles together. The stabilization process requires fines in order to be effective.

It is recommended that adequate pre-engineering be carried out on the project and that existing pavement thicknesses and composition be established. Additional investigation should be carried out when pavement composition changes, such as patched areas. Pre-engineering data should be included in the contract documentation.

The selected performance graded asphalt cement (PGAC) must have suitable expansion characteristics. Polymer modified PGAC may adversely affect the foaming process. There is no requirement for a PGAC to be selected based on climatic zones, as the stabilized layer is expected to have good fatigue properties and should not be prone to low temperature cracking.

Since EAM has a higher structural equivalency than granular base material, it is suitable for pavement strengthening purposes where aggregate availability is low or where elevation restrictions exist.

This specification requires that the EAM be paver laid, i.e., be placed by a self-propelled mechanical paver. If an Owner would like the EAM to be grader laid, i.e., to allow the use of a grader to place the EAM, a special provision to allow that option should be included in the Contract Documents.

When additional full-depth reclamation is required beyond the limits of the expanded asphalt stabilization, the depth and limits of full-depth reclamation should be clearly indicated in the Contract Documents. (331.07.02)

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When compaction is to be determined according to OPSS 501 Method B, a minimum roller size should be specified.

A minimum 2-Day curing period is recommended prior to overlaying the EAM. The EAM should be surfaced as soon as possible after curing, as the mix is susceptible to damage by traffic and rain.

A tack coat is recommended on the EAM prior to hot mix overlay.

EAM is typically overlain with hot mix asphalt. A surface treatment or slurry surfacing may be considered; however, this specification may require modification.

Contract scheduling should allow for stabilization and overlay to be completed within the hot mix temperature operational constraints.

QC requirements have been removed from this specification, as acceptance is based on QA testing. If an Owner requires Contractor QC to confirm that the work meets the specification requirements, a special provision detailing the required Contractor QC should be included in the Contract Documents.

The payment clause for this specification is all inclusive. Should an Owner desire to pay for corrective aggregate, active filler, or asphalt cement separately, separate payment items are required.

In times of volatile asphalt cement prices, on multi-year contracts, and on Contracts with greater than 1,000 tonnes of paver laid EAM material, designers may consider using the MTO PGAC price index for payment adjustment. The MTO PGAC price index is available on the Ontario Ministry of Transportation website at www.raqs.mto.gov.on.ca, by clicking on Contractor, Contract Bulletin, Asphalt Price Index. The MTO PGAC price index is only a tool for qualifying PGAC prices and is not intended as a standard asphalt cement price to be incorporated into the contract bid. The MTO PGAC price index calculation for a given month takes in the average of the 4 weeks of the month and is published on the last day of the month.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

CONSTRUCTION SPECIFICATION FOR HOT IN-PLACE RECYCLING

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332-A Commentary

332.01 SCOPE

This specification covers the requirements for the preparation of the existing pavement surface; heating and hot milling the existing hot mix asphalt; adding and mixing in one or more of rejuvenating agent and beneficiating hot mix asphalt; and redistribution and compaction of the Hot In-Place Recycled mix in a single operation.

332.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be as specified in the Contract Documents.

332.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

332.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 310 Hot Mix Asphalt

Ontario Provincial Standard Specifications, Material

OPSS 1101 Performance Graded Asphalt Cement
OPSS 1150 Hot Mix Asphalt
OPSS 1151 Superpave and Stone Mastic Asphalt Mixtures

Ontario Ministry of Transportation Publications

MTO Laboratory Testing Manual

LS-261 Preparation of Marshall Specimens
LS-262 Bulk Relative Density of Compacted Bituminous Mixes
LS-263 Resistance to Plastic Flow of Bituminous Mixtures using Marshall Apparatus
LS-264 Theoretical Maximum Relative Density of Bituminous Paving Mixtures
LS-265 Determination of Percent Air Voids in Compacted Dense Bituminous Pavement Mixtures
LS-282 Quantitative Extraction of Asphalt Cement and Analysis of Extracted Aggregate from Bituminous Paving Mixtures
LS-284 Recovery of Asphalt from Solution by Abson Method or Rotavapor
LS-287 Determination of Percent Compaction of Compacted Bituminous Paving Mixture (MRD Method)

LS-292 Quantitative Determination of Asphalt Cement Content by Ignition and Analysis of Remaining Aggregate from Bituminous Paving Mixtures
LS-306 Bulk Relative Density of Compacted Bituminous Mixtures Using Paraffin Coated Specimens

ASTM International

D 6752-11 Standard Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Automatic Vacuum Sealing Method

American Association of State Highway and Transportation Officials (AASHTO)

M 323-13 Superpave Volumetric Mix Design
T 166-13 Bulk Specific Gravity of Compacted Bituminous Mixtures Using Saturated Surface-Dry Specimens
T 209-09 Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures
T 275-07 Bulk Specific Gravity of Compacted Bituminous Mixtures Using Paraffin-Coated Specimens

332.03 DEFINITIONS

For the purpose of this specification, the definitions in OPSS 310, OPSS 1150, OPSS 1151, and the following definitions apply:

Asphalt Cement (AC) means asphalt binder as defined in OPSS 1101.

Attribute means one of the following properties: designated large sieve (DLS), 4.75 mm sieve, 75 µm sieve, AC content, air voids, lift thickness, compaction, or recovered asphalt cement (RAC) performance grade.

Beneficiating HMA means a HMA designed so that the final HIR mix shall be as specified in the Contract Documents.

Design Lift Thickness (T_D) means the thickness in millimetres of the HIR mix as specified in the Contract Documents.

High Temperature Performance Grade (XX) means the high temperature performance grade specified in the Contract Documents and also referred to as the XX specified for the RAC where the RAC grade specified is PG XX-YY, and the maximum design pavement temperature.

Hot In-Place Recycled (HIR) Mix means the mixture of hot milled material containing one or more of the following components: rejuvenating agent and beneficiating HMA.

Hot Milled Material means the material produced during the heating and hot milling of the existing HMA.

Hot Milling means the process of applying adequate heat to the pavement to sufficiently soften the pavement, followed by the use of milling heads to uniformly remove the heated material to the depth specified in the mix design submission with minimal fracturing of the existing aggregates.

Joint means a vertical contact between a HIR mix and any pavement or any rigid object that exists at the time the HIR mix is laid.

Lift Thickness means the thickness in millimetres of the placed and compacted HIR mix.

Loose Mix means a representative sample of uncompacted HIR mix for testing mix properties or the RAC performance grade.

Low Temperature Performance Grade (-YY) means the low temperature performance grade specified in the Contract Documents and also referred to as the -YY specified for the RAC where the RAC grade specified is PG XX-YY, and the minimum design pavement temperature.

Mix Design means the design of the proportions of new and existing aggregates; new and existing AC; rejuvenating agent; and additives; when uniformly mixed, that results in an acceptable HIR mix.

Mix Properties means the AC content, gradation, and air voids.

Recovered Asphalt Cement (RAC) means the AC recovered from the HIR mix according to the Rotavapor Method in LS-284, using re-agent grade tricholorethylene, or other solvent acceptable to the Owner.

Rejuvenating Agent means a product that when added to the hot milled material; the RAC from the HIR mix meets the requirements of the Contract Documents.

Screed means the unit of the placement unit of the recycling train that strikes off and imparts initial compaction to the HIR mix.

332.04 DESIGN AND SUBMISSION REQUIREMENTS

The HIR mix design shall be as specified in the Contract Documents and according to the Design and Submission Requirements section of OPSS 1150 for HIR mixes required to meet a Marshall mix type and OPSS 1151 for HIR mixes required to meet a Superpave mix type.

HIR mix designs shall not incorporate RAP from other sources or RST into the HIR mix.

The following additional information shall be submitted to the Contract Administrator in writing with the mix design:

a) The amount, name, manufacturer, and supplier of the rejuvenating agent or beneficiating HMA or both, if to be used;

b) The hot milling depth to meet the required mix properties and the design lift thickness, as specified in the Contract Documents, with a maximum increase in pavement elevation of 15.0 mm;

c) The mix proportions, gradation, and source of the materials in the beneficiating HMA, if to be used;

d) A copy of all calculations that were completed to determine the amount of rejuvenating agent or beneficiating HMA or both, if to be used;

e) Air void laboratory test results and calculations for the HIR mix; and

f) A graph of temperature-kinematic viscosity relationship for the combined rejuvenating agent, the recovered AC present in the existing pavement, and the new AC in the beneficiating HMA.

g) When applicable, a declaration that the percentage of the beneficiating HMA comprising quartzite and dolomitic sandstone aggregates, or combinations thereof, is more than 75%.

Each mix design shall be valid for the section of roadway it was designed for.

332.05 MATERIALS

332.05.01 Hot In-Place Recycled Mix

The HIR mix produced shall be according to the mix design and meet the requirements of Tables 1, 2, and 3. For HIR mix required to meet a Marshall mix type, the HIR mix produced shall also meet the requirements of Table 4.

332.05.01.01 Recovered Asphalt Cement

The RAC recovered from the HIR mix produced shall be according to the Materials section of OPSS 1101 for PGAC and as specified in the Contract Documents.

332.05.01.02 Beneficiating Hot Mix Asphalt

The materials used in the production of the beneficiating HMA shall be according to OPSS 1150 for HIR mixes required to meet a Marshall type and OPSS 1151 for HIR mixes required to meet a Superpave mix type.

The composition of the beneficiating HMA shall not contain RAP or RST.

332.05.02 Release Agents

No release agents shall be used that may adversely affect the quality or performance of the HIR mix. Release agents shall be used according to the proprietary requirements.

Petroleum based release agents, excess water, or excess release agents shall not be used.

332.06 EQUIPMENT

332.06.01 Paving Equipment

Paving equipment shall be according to OPSS 310.

332.06.02 Rollers

Rollers shall be according to OPSS 310.

332.06.03 Heating Unit

Heating units shall apply heat in a uniform manner to the surface of the existing pavement to be hot milled. Open flame heating of the existing HMA pavement shall not be permitted.

Heaters shall be spaced and operated so that:

a) Sufficient heat penetration of the pavement shall be achieved, with heat penetration into the underlying pavement beneath the hot milling depth specified in the mix design submission;

b) The desired HIR mix temperatures are achieved; and

c) The existing HMA surface is not burnt or scorched.

332.06.04 Recycling Train

The recycling train shall be self-contained mechanical units specifically designed for HIR of HMA pavements. The recycling train shall have the capability to process the existing pavement to a depth of at least 50 mm.

Heaters used as part of the recycling train shall be according to the Heating Unit subsection.

The recycling train shall include hot milling, blending, and placement units.

332.06.04.01 Hot Milling Unit

The hot milling unit shall be capable of uniformly milling the preheated HMA to the hot milling depth specified in the mix design submission.

332.06.04.02 Blending Unit

The blending unit shall be capable of thoroughly mixing the hot milled material, rejuvenating agent, and beneficiating HMA.

332.06.05 Diamond Grinding

A diamond grinder shall be power-driven, self-propelled, and designed for grinding HIR mix or HMA. It shall be equipped with a grinding head with at least 50 diamond blades per 300 mm of shaft. The grinding head shall be at least 0.9 m wide. The grinder shall be equipped with the capability to adjust the depth, slope, and crossfall to remove HIR mix or HMA to the required profile and shall also include a slurry pick-up system.

332.07 CONSTRUCTION

332.07.01 Quality Control

QC procedures shall be conducted to ensure the HIR mix meets the requirements of the Contract Documents. The Contractor shall be responsible for interpretation of the QC test results and the determination of any action to be taken to ensure that all materials and work are as specified in the Contract Documents. QC documentation shall be made available to the Contract Administrator upon request. Sampling and testing methods shall be included in the QC documentation.

A laboratory that has current CCIL Type B Certification or AMRL equivalent certification or other equivalent certified laboratory acceptable to the Contract Administrator shall be used. Testing of the samples shall be conducted under the direct and constant supervision of technicians certified to perform the QC tests according to CCIL or equivalent certification.

A single sample for QC purposes may be obtained at the same time and location as QA acceptance samples. No additional loose mix samples shall be taken from the placed HIR mix.If further additional samples are required, a written request shall be made to the Contract Administrator, and samples shall only be taken upon written approval of the Contract Administrator. All sample locations shall be restored as specified in the Contract Documents.

332.07.02 Preparation of Existing Pavement

Prior to the HIR operation:

a) Existing HMA surfaces shall be clean and free of all loose, broken, and foreign materials.

b) Milled existing HMA surfaces shall be clean and free of all loose, broken, and foreign materials and shall be swept with a power broom.

c) Removal of cold mix patching material, crack sealant, and spray patch material shall be as specified in the Contract Documents (FS: pp 44)

Existing surfaces to be HIR may be corrected by additional cold milling, hot milling, addition of beneficiating HMA or a combination, in order to place and compact the HIR mix to the design thickness specified in the Contract Documents.

Removal of the existing pavement by the hot milling unit shall be performed in such a manner as to leave adjacent pavement and structures remaining in place undisturbed and undamaged. All damaged or disturbed portions shall be corrected expeditiously and repaired to the satisfaction of the Contract Administrator. Broken edges of portions to be left in place that are visible after construction shall be squared and neatly trimmed.

332.07.03 Transportation of Beneficiating Hot Mix Asphalt

The beneficiating HMA shall be transported from the asphalt plant to the work in leak proof truck boxes that have been previously cleaned of all foreign materials. If required, truck boxes shall be lightly coated with a uniform application of a release agent. Truck boxes shall be drained after each application and before loading.

Each truck shall use a tarpaulin of sufficient size to completely cover the load at all times.

332.07.04 Placing Hot In-Place Recycled Mix

332.07.04.01 Operational Constraints

The HIR process shall not be carried out if the roadbed is frozen.

The surface of a pavement which is to be HIR shall be dry at the time of the HIR processing. The HIR process shall be carried out when the roadway is clean and free of standing water. The HIR process shall not proceed in the rain.

The supply of any materials to the recycling train shall be accomplished with no traffic on the uncompacted mat. Public traffic shall not be permitted on freshly laid HIR mix until the temperature of the mat is 50 °C or less.

332.07.04.02 Paving

The heating units and recycling train shall heat and hot mill the HMA pavement across the complete lane width, and partial width shoulder if applicable, to the hot milling depth specified in the mix design submission.

The underlying pavement shall be heated to a minimum temperature of 50 ºC.

When inspection and testing indicates that the required average depth of heating and hot milling is not being met, the process shall be immediately corrected.

Rejuvenating agent and/or beneficiating HMA shall be added to and mixed with the hot milled material in the amount specified in the mix design. The HIR mix shall be homogeneous after mixing.

The final placement of the HIR mix by the recycling train shall be uniformly distributed to the specified profile and crossfall. The HIR mix shall be compacted to the design lift thickness specified in the Contract Documents and meet all acceptance criteria specified in the Contract Documents.

Each successive pass of the recycling train shall overlap the previously HIR adjacent surface by a minimum of 100 mm.

The temperature of the HIR mix immediately behind the screed and prior to rolling shall not be less than 120 °C.

Prior to roller compaction, obvious defects in the HIR mix placed shall be corrected. Irregularities in the alignment and grade along the outside edges shall be corrected. Excess HIR mix shall not be cast onto the surface of the freshly laid mat. After final compaction the surface shall be smooth and true to the established crown and grade, uniform in texture and shall be free of any defects.

All through lane HIR mix shall be completed prior to the placement of adjacent sideroads, speed change lanes, and other paved areas.

Areas that are not accessible to the heating and hot milling equipment shall have the HMA removed to the depth required to meet the design lift thickness requirements specified in the Contract Documents. These areas shall be tacked coated and paved with the HMA mix type the HIR is required to meet according to OPSS 310. The surface of each layer placed and compacted shall be level with the adjacent pavement. The paving of such areas shall be completed prior to the placing of any subsequent course on the HIR mix, if applicable, and as a separate operation from any other paving.

If the Contractor's actions fail to prevent continued medium or severe segregation regardless of cause, the Contract Administrator may instruct the Contractor to cease HIR operations until the problem has been corrected.

332.07.05 Longitudinal and Transverse Joints

All joints shall be made to obtain a complete bond between the two pavement edges and a smooth riding surface. The existing or previously placed pavement edge shall be a straight clean vertical surface for the full depth of the course. Where ramping or damage has occurred, trimming shall be required. All dirt or other foreign material and all loose material shall be removed from all vertical surfaces.

Longitudinal and transverse joints between the new HIR pavement and the existing pavement shall be butt joints as specified in the Contract Documents. All longitudinal joints at intersecting roads shall be butt joints. Heating beds on the heating units shall heat and soften material beyond the hot milling width by a minimum of 100 mm to achieve proper thermal bonding between the existing asphalt pavement and the HIR mix along the longitudinal joints. The longitudinal joints shall be parallel to the lane and visually uniform longitudinally, and within 50 mm of the demarcation between the lanes specified in the Contract Documents.

When matching a compacted joint, the depth of the uncompacted mat shall be set to allow for compaction. The paver screed shall overlap the adjoining mat by at least 50 mm.

332.07.06 Compaction

Compaction of the HIR mix shall be conducted using appropriate methods and equipment to provide a uniformly compacted mat according to the compaction requirements as per OPSS 310.

At all places not accessible to rollers, the HIR mix shall be compacted by mechanical self-powered gas-, electric-, or air-powered equipment.

332.07.07 Sampling

332.07.07.01 General

Samples shall be taken in accordance with the Contract Documents under the direction and in the presence of the Contract Administrator. Samples shall be placed in an appropriate container supplied by the Owner.

HIR mix and compaction requirements for filling all sample holes shall be the same as the adjacent undisturbed pavement. Sample holes shall be cleaned, dried, and filled and then compacted using a mechanical self-powered gas-, electric-, or air-powered compactor immediately after sampling.

332.07.07.01.01 Labelling

All samples shall be labelled with the following:

a) Contract number.

b) Location of sampling.

c) Date (i.e., yyyy-mm-dd) and time of sampling.

d) Asphalt type.

332.07.07.02 Hot In-Place Recycled Mix

The Contractor is responsible for obtaining QA and referee HIR mix samples using sample plates for Marshall mixes and other methods approved by the Contract Administrator for Superpave mixes.

When the mass of the sample does not meet the requirements of Table 5, the sample shall be discarded and a new one taken immediately.

332.07.07.02.01 Frequency and Location

The minimum frequency for sampling and testing shall be as specified in Table 5.

332.07.07.03 Lift Thickness Cores

The Contractor is responsible for obtaining QA and referee lift thickness core samples.

Each core shall be 100 mm in diameter, and shall consist of the full layer being sampled and at least one underlying layer, if one is present. Cores shall not be taken within 250 mm of a longitudinal or transverse joint or the edge of pavement.

332.07.07.03.01 Frequency and Location

The minimum frequency for sampling and testing shall be approximately once every 100 m along the length of the roadway or 300 m^2 of pavement surface.

332.07.07.04 Compaction Cores

When a coring and testing program is undertaken to resolve a dispute related to HIR compaction, the Contractor shall be responsible for all traffic control required to carry out the coring, obtaining, and labelling the core samples, delivery of the samples to a mutually agreed upon third party referee laboratory, and repairing core sample holes.

Each core shall be 150 mm in diameter, and shall consist of the full layer being sampled and at least one underlying layer, if one is present. Cores shall not be taken within 250 mm of a longitudinal or transverse joint or the edge of pavement.
Each set of samples shall be taken from the same lane, same transverse offset, and at a spacing of 1.0 m $\pm$ 0.1 m between each individual core edge.

Care shall be taken to ensure that cores are not damaged during coring operations or in transit. If a core is damaged, a replacement core shall be extracted at a location adjacent to the original core.

332.07.07.04.01 Frequency and Location

The minimum frequency of sampling and testing shall be as determined by the Contract Administrator.

332.07.08 Management of Excess Material

Management of excess material shall be as specified in the Contract Documents.

332.08 QUALITY ASSURANCE

332.08.01 General

The Contract Administrator is responsible for conducting QA procedures for all HIR attributes to meet the requirements of the Contract Documents. QA HIR testing shall be conducted at a frequency specified in Table 5 or as specified in the Contract Documents.

All QA testing shall be completed in a certified laboratory that is CCIL Type B or C, or AMRL accredited, or equivalent.

When the HIR fails to meet the requirements of the Contract Documents, the Contract Administrator may refuse further material until the mix properties are verified for compliance by one of the following methods:

a) For Marshall mixes, samples shall be used to determine compliance to asphalt cement content, aggregate gradation, air voids, flow, voids in mineral aggregate, and stability requirements.

b) For Superpave mixes, samples shall be used to determine compliance to asphalt cement content, aggregate gradation, and Superpave mix properties in accordance to AASHTO M 323.

332.08.02 Surface Tolerance

After final compaction, HIR mix shall be smooth and true to the established crown and grade. HIR mix shall be free from deviations exceeding 3 mm as measured in any direction with a 3 m straight edge. Defective areas shall be removed and replaced with acceptable HIR or HMA pavement and compacted to the satisfaction of the Contract Administrator.

332.08.03 Surface Appearance

The Contract Administrator may reject visually defective HIR areas based on, but not limited to the following defects: flushing, segregation, fat spot, surface damage, roller marks, or surface contamination. Defective areas shall be removed from the work and replaced with acceptable HIR or HMA pavement and compacted to the satisfaction of the Contract Administrator.

332.08.04 Asphalt Cement Content and Aggregate Gradation Acceptance

Aggregate gradation and asphalt cement content test results for HIR mix samples based on LS-282 and LS-292 shall meet the requirements specified in Table 1.

If the HIR mix is deemed borderline for aggregate gradation or asphalt cement content according to Table 1, the Contractor shall be notified in writing by the Contract Administrator and shall take immediate corrective action through process control. A total of three borderline test results for the same attributes representing up to 40,000 m^2 of HIR production shall result in the work being deemed rejectable.

Test results shall be acceptable if they meet the requirements specified in Table 1. If the HIR mix is deemed rejectable according to Table 1, both the Contract Administrator and the Contractor shall review, agree, and

identify the limits of rejected HIR mix that has been placed. Referee samples within the limits of the affected area shall be delivered by the Contractor to a mutually agreed upon third party referee laboratory to verify aggregate gradation or asphalt cement content or both. When the results from the referee samples are deemed rejectable according to Table 1, the HIR mix shall be removed and replaced with acceptable HIR or HMA pavement. Alternatively, the Contract Administrator may accept a guaranteed maintenance bond, an increased maintenance period, or a negotiated price adjustment.

332.08.05 Mix Properties Acceptance

The production air voids for all HIR mixes shall be evaluated according to Table 2. Marshall test results for HIR mix samples based on LS test procedures shall also meet the requirements specified in Table 4.

If the HIR mix is borderline for air voids as specified in Table 2, the Contractor shall be notified in writing by the Contract Administrator and shall take immediate corrective action through process control.

If the HIR mix does not meet Table 4 minimum requirements for Marshall stability or Marshall flow or is deemed rejectable for air voids according to Table 2, both the Contractor Administrator and the Contractor shall review, agree, and identify the limits of the rejected HIR mix that has been placed. Referee samples within the limits of the affected area shall be delivered by the Contractor to a mutually agreed upon third party referee laboratory to verify Marshall test or air voids results or both. When the results from the referee samples do not meet Table 4 minimum requirements or are deemed rejectable according to Table 2, the HIR mix shall be removed and replaced with acceptable HIR or HMA pavement. Alternatively, the Contract Administrator may accept a guaranteed maintenance bond, an increased maintenance period, or a negotiated price adjustment.

332.08.06 Lift Thickness Acceptance

The average thickness for a lift thickness core shall be based on the measurement from each quadrant of the core. The average thickness for the area shall be determined by averaging the core thicknesses.

When the average thickness is more than or equal to 95% of the specified thickness, the total surface area of the HIR mix is acceptable.

When the average thickness is less than 95% of the specified thickness, the area represented by the lift thickness core shall be subject to a payment adjustment as specified in the Payment Adjustment for Lift Thickness subsection.

332.08.07 Recovered Asphalt Cement Performance Grade Acceptance

All RAC test samples shall be obtained by recovery according to the Rotavapor Method in LS-284 using re-agent grade tricholorethylene, or other solvent acceptable to the Owner, from the loose mix HIR mix samples taken as specified in Table 5.

Test results that do not comply with the performance grading requirements shall be categorized as borderline or rejectable. RAC test results shall be categorized based on each test result's deviation from the individual design maximum or minimum pavement temperature and the sum of the deviations from the design maximum or minimum pavement temperatures defined as specified in Table 6. The actual performance grading that is either higher than the maximum design pavement temperature or lower than the minimum design pavement temperature is not considered a deviation.

If the HIR mix is deemed borderline for RAC performance grade according to Table 6, the Contractor shall be notified in writing by the Contract Administrator and shall take immediate corrective action through process control. A total of three borderline test results for the same attributes representing up to 40,000 m^2 of HIR production shall result in the work being deemed rejectable.

Test results shall be acceptable if they meet the requirements specified in Table 6. If the HIR mix is deemed rejectable according to Table 6, both the Contract Administrator and the Contractor shall review, agree, and identify the limits of rejected HIR mix that has been placed. Referee samples within the limits of the affected area shall be delivered by the Contractor to a mutually agreed upon third party referee laboratory to verify the RAC performance grading. When the results from the referee samples are deemed rejectable according to Table 6, the HIR mix shall be removed and replaced with acceptable HIR or HMA pavement. Alternatively, the Contract Administrator may accept a guaranteed maintenance bond, an increased maintenance period, or a negotiated price adjustment.

332.08.08 Compaction Requirements

332.08.08.01 General

Compaction testing of the placed HIR mix shall meet the requirements specified in Table 3.

Nuclear density test gauge results shall be used to assess in-place compaction. When compaction test results do not meet the minimum percent compaction specified in Table 3, the Contractor shall be notified in writing and either the affected area of HIR shall be removed and replaced with acceptable HIR or HMA, or in the case of a dispute, the Contractor or the Owner may request that a coring and testing program be undertaken to verify compaction percentage of the mix. The cores shall be provided to the Owner and compaction shall be determined according to the Compaction Determined by Core Density Testing clause using a mutually agreed upon third party referee laboratory. When compaction results from core densities do not meet the minimum percent compaction specified in Table 3, the HIR shall be removed and replaced with acceptable HIR or HMA.

332.08.08.02 Compaction Determined by Nuclear Density Gauge

Compaction testing shall be conducted randomly at a minimum frequency of every 100 m per lane or 150 m^2 area.

332.08.08.02.01 Marshal Hot In-Place Recycled Mix

Percent compaction shall be determined by comparing the nuclear density in situ Bulk Relative Density (BRD) according to LS-262 to the average plant produced Maximum Relative Density (MRD) according to LS-264.

332.08.08.02.02 Superpave Hot In-Place Recycled Mix

Percent compaction shall be determined by comparing the nuclear density in situ BRD to the average plant produced MRD both according to AASHTO T 209.

332.08.08.03 Compaction Determined by Core Density Testing

332.08.08.03.01 Marshall Hot In-Place Recycled Mix

Density testing of the cores shall be according to LS-287. Percent compaction shall be determined by comparing the core BRD according to LS-262 to the average MRD according to LS-264 of the plant produced HIR.

332.08.08.03.02 Superpave Hot In-Place Recycled Mix

Density testing of the cores shall be according to AASHTO T 166. If the percent water absorbed by the specimen is found to exceed 2% by volume as described in AASHTO T 166, then the bulk specific gravity shall be according to AASHTO T 275, LS-306, or ASTM D 6752. Percent compaction shall be determined by comparing the core BRD to the average MRD both according to AASHTO T 209 of the plant produced HIR.

332.09 MEASUREMENT FOR PAYMENT

332.09.01 Actual Measurement

332.09.01.01 Hot In-Place Recycled Mix

Measurement of HIR mix shall be by the horizontal area in square metres in place.

332.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement is based on the units shown in the clauses under Actual Measurement.

332.10 BASIS OF PAYMENT

332.10.01 Hot In-Place Recycled Mix– Item

Payment at the Contract price for the above tender item shall include full compensation for all labour, Equipment, and Materials required to do the work, including rejuvenating agent and beneficiating HMA quantities if used, and the applicable payment adjustments.

No additional payment shall be made for the work, labour, Equipment, and Materials required to remove the existing pavement, and place HMA in areas not accessible to the heating and hot milling equipment.

The preparation and correction of existing HMA surfaces carried out in order to meet the requirements of the Contract Documents, including removal of materials such as cold mix patching material, crack sealant, and spray patch material; cold milling, hot milling, and the addition of beneficiating HMA; shall be at no cost to the Owner.

HMA required to retrofit partially paved shoulders or for pavement widening shall be paid for at the Contract price for the appropriate HMA tender item. No additional payment shall be made under this item for HMA required to retrofit partially paved shoulders or for pavement widening.

When removing and replacing HIR mix, the Contractor shall be responsible for and shall carry out all associated work and replace or restore all associated damage and removals at no cost to the Owner.

Referee testing undertaken to resolve a dispute shall be at no extra cost to the Owner if the referee test results confirm that the HIR mix does not meet the requirements or is deemed borderline or rejectable according to the Quality Assurance section.

A coring, testing, and traffic control program undertaken to resolve a dispute shall be at no extra cost to the Owner if the HIR mix compaction is confirmed to not meet the requirements of the Compaction Requirements subsection.

When the Contract Administrator instructs the Contractor to cease HIR operations due to continued medium or severe segregation regardless of cause, the Owner shall not be held responsible for any additional costs that the Contractor may incur.

332.10.02 Payment Adjustment for Lift Thickness

When the average thickness is less than 95% of the specified thickness, the area represented by the lift thickness core shall be subject to a payment adjustment calculated as follows:

$$\text{Payment for the area} = \frac{\text{area} \times \text{average thickness}}{\text{specified thickness}}$$

TABLE 1
Asphalt Cement Content and Aggregate Gradation Tolerance Requirements

Properties and Attributes	Tolerance on	Tolerances %		
		Acceptable	Borderline	Rejectable
Asphalt Cement Content	Asphalt Cement Content specified (Note 1)	< 0.30	0.30 to 0.50	> 0.50
Designated Large Sieve (DLS)	Maximum and Minimum Percent Passing (Note 2 & 3)	< 1.0	1.0 to 5.0	> 5.0
4.75 mm Sieve	Maximum and Minimum Percent Passing (Note 2 & 3)	< 1.0	1.0 to 5.0	> 5.0
75 µm Sieve	Maximum Percent Passing (Note 2)	< 1.0	1.0 to 3.0	> 3.0
	Minimum Percent Passing (Note 3)	< 1.0		> 1.0

Notes:
1. Tolerances on the asphalt cement content specified in the Contract Documents apply as both plus and minus from the asphalt cement content specified in percent.
2. Tolerances on the maximum percent passing apply as plus from the maximum percent passing by dry mass of aggregate for the mix type the HIR mix shall be according to OPSS 1150 for Marshall mixes and OPSS 1151 for Superpave mixes.
3. Tolerances on the minimum percent passing apply as minus from the minimum percent passing by dry mass of aggregate for the mix type the HIR mix shall be according to OPSS 1150 for Marshall mixes and OPSS 1151 for Superpave mixes.

TABLE 2
Air Voids Requirements (LS-265)

Properties and Attributes	Mix Type HIR Mix is Required to Meet	Acceptable %	Borderline %	Rejectable %
Air Voids	DFC	2.0 to 4.5	1.5 to 1.9 and 4.6 to 5.0	< 1.5 and > 5.0
	All Other Mixes	2.5 to 5.0	1.5 to 2.4 and 5.1 to 6.0	< 1.5 and > 6.0

TABLE 3
Minimum Pavement Compaction Based on Maximum Relative Density

Properties and Attributes	Minimum Compaction %
Pavement Compaction	92.0

TABLE 4
Marshall Stability and Flow Properties

Mix Type HIR Mix is Required to Meet	Marshall Flow at 3.5% Air Voids: LS-261 and LS-263	Minimum Marshall Stability: Newtons (N) at 60 °C, LS-261 and LS-263
DFC	8.0 minimum	(Note 1)
HL 1, HL 3, and HL 4,	8.0 to 14.0	
HL 3F	9.0 to 18.0	
Notes: 1. Stability requirements shall be according to OPSS 1150.		

TABLE 5
Sampling and Testing of Hot In-Place Recycled Mix

Material Sample	Properties and Attributes	Quantity Per Day Per HIR Mix Type	Minimum Frequency of Sampling and Testing (Note 1)	Minimum Sampling Size
HIR Loose Mix	Asphalt Cement Content, Aggregate Gradation, and Mix Properties	≤ 4,000 m^2	One sample	20 kg (Note 2)
		> 4,000 and ≤ 12,000 m^2	One sample per 4,000 m^2 or part thereof	
		> 12,000 m^2	One sample per 4,000 m^2 (Note 2), minimum of 3	
HIR Loose Mix	RAC Performance Grade	Any	One sample per 40,000 m^2	10 kg
HIR Lift Thickness Core	Lift Thickness	Any	every 100 m along the length of the roadway or 300 m^2 of pavement surface	100 mm in diameter
HIR Compaction Core	Pavement Compaction	Any	every 100 m per lane or 150 m^2 of pavement surface	150 mm in diameter (Note 3)
Notes: 1. The Contract Administrator may reduce the testing frequency for HIR mix that is consistently being produced to meet the specification requirements. 2. For HIR mixes required to meet Marshall mix requirements the minimum sampling size shall be 10 kg. 3. HIR compaction core only required when compaction shall be determined by core density testing as specified in the Contract Documents.				

TABLE 6
Performance Grading Requirements and Categories for RAC

Category	**Deviation** (Note 3)	**RAC Requirements**
Borderline (Note 1)	below XX and	≤ 6 °C
	above -YY and	≤ 8 °C
	Sum	> 8 °C and ≤ 12 °C
Rejectable (Note 2)	below XX or	> 6 °C
	above -YY or	> 8 °C
	Sum	> 12 °C

Notes:
1. Performance grading shall be deemed borderline when both the individual deviations and the sum of deviations specified for the category are met.
2. Performance grading shall be deemed rejectable when any individual deviation or the sum of deviations specified for the rejectable category is met.
3. XX is the specified high temperature performance grade and design maximum pavement temperature. -YY is the specified low temperature performance grade and design minimum pavement temperature.

Appendix 332-A, November 2016
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specifications in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should be aware of the following when selecting HIR:

HIR is limited to resurface pavements exhibiting only surficial distresses. HIR should be considered for roads with the following distress manifestations:

- Very slight to moderate ravelling / coarse aggregate loss, segregation, very slight to moderate flushing, and/or distortions

- Few to frequent very slight to moderate non-working cracks

- For 2 lane highways up to 1.0% correction in crossfall can be achieved across a single lane width using HIR, provided there are no bridge clearance or grade raise restrictions

- For multi-lane highways correction of crossfall with HIR is not recommended

HIR is not suitable for pavements exhibiting structural distresses, i.e. alligator cracking, lack of structural capacity, working cracks, severe distortions, and/or instability rutting. HIR is not suitable for pavements exhibiting severe or very severe ravelling / coarse aggregate loss due to stripping.

HIR is not permitted for use on bridge decks; therefore, if the contract contains multiple bridges that require paving, the designer should consider whether stopping and starting the HIR process at each bridge is acceptable for the contract.

HIR is recommended only for existing flexible pavements, excluding SMA, with a minimum asphalt pavement thickness of 70 mm. The specified HIR lift thickness is 40 mm to a maximum of 50 mm (including any beneficiating HMA). The measured lift thickness is the actual lift thickness of the HIR placed and may or may not be equal to the hot milling depth. A minimum of 25 mm of existing asphalt pavement should be maintained below the HIR.

The HIR process should not be used to recycle SMA or composite pavements.

HIR must be placed in warm, dry weather; and therefore, HIR contracts should be tendered so that the HIR work can be carried out between May 15th and October 15th, inclusive.

The designer should note that HIR equipment may be restricted to a specific processing width. The equipment is usually able to process a width of up to 4.0 m. This could restrict the use of HIR with partially paved shoulders. However, the placement width is similar to that of a conventional paver, and partially paved shoulders that cannot be removed along with the lane, due to the restricted processing width, could be removed conventionally ahead of the HIR operation to allow the new partially paved shoulder to be placed in conjunction with the lane. Partially paved shoulders that cannot be accommodated as part of the lane placement width and fully paved shoulders, if these are to be HIR, require a separate pass of the HIR equipment.

HIR is usually considered for projects at least 20 lane-kilometres, including fully paved shoulders. Partially paved shoulders and pavement widening can be retrofitted using this process. Advance grading and

compaction of the shoulders is required as well as beneficiating HMA to make up the extra being placed on the shoulders or in pavement widening.

The following information is given for estimating purposes only.

HIR can be considered a suitable resurfacing treatment for a project where the pre-engineering cores meet the following guidelines:

1. The existing aggregate gradation should meet the gradation requirements of mix type the HIR is required to meet, or be close enough that a reasonable amount of beneficiating HMA could be added to meet these requirements.

2. The RAC performance grade from the extracted AC of the existing asphalt pavement can achieve the target performance grade using the blending calculations in AASHTO M 323 for rejuvenator products and new PGAC added to a beneficiating HMA.

3. Average in-situ air voids of:
   > 4.5% a beneficiating HMA is normally not required,
   ≤ 4.5% and > 2.0% beneficiating HMA may be required, and
   ≤ 2.0% the designer should expect beneficiating HMA to be required.

   Generally in-situ air voids are between 2.0 and 2.5% for asphalt pavements 10 to 15 years old.

4. The existing pavement conditions should not vary greatly from one core to the next.

The designer should specify the following in the Contract Documents:

- HIR crossfall, profile, cross-section, and alignment. (323.03)

- HMA mix type the HIR mix is required to meet. A Marshall mix type or Superpave 12.5 mix type should be selected based on existing materials from the following list: (332.04)

- Design thickness. (323.04)

  A. Superpave 12.5
  B. Superpave 12.5FC 1
  C. Superpave 12.5FC 2
  D. DFC
  E. HL 1
  F. HL 3
  G. HL 3F
  H. HL 4

- The RAC recovered from the HIR mix produced. (332.05.01.01)

- Quality assurance sample requirements. (332.07.01)

- HIR sample delivery location. (332.07.01)

- Removal of cold mix patching material, crack sealant, and spray patch material. (332.07.02)

- Lane demarcation. (332.07.05)

- Longitudinal and transverse joints. (332.07.05)

- Management of excess material. (332.07.08)

- QA HIR testing frequency if different than OPSS 332, Table 5. (332.08.01)

- Performance grade requirement for RAC. (332.08.07)

- Asphalt cement content specified. (Table 1)

- HIR compaction core. (Table 5)

Any available core data on existing pavement conditions should be included in the bidding documents for information only.

The designer should determine if the following is required and, if so, specify in the Contract Documents:

The designer may specify in a special provision when quality control (QC) test results are to be used for acceptance in place of QA test results.

The designer may consider extending delivery times for samples required on Contracts in remote areas. The designer should be aware that there is a 4 hour delivery requirement for samples and the laboratory should be open to receive them.

For smaller projects, the borderline category for tolerances in Table 1 may not be appropriate. The designer may consider specifying that all work represented by borderline test results shall be deemed rejectable.

The complete tender item description for HIR should include a “type” of HMA according to Table 1 of OPSS 1150 for HIR mixes required to meet Marshall mixes and according to Tables 1 and 2 of OPSS 1151 for HIR mixes required to meet Superpave mixes.

The designer should consider specifying that prior to HIR all materials such as cold mix patching material, crack sealant, and spray patch material shall be removed or that the Contractor shall be responsible for preparing the existing HMA surface by removing all materials such as cold mix patching material, crack sealant, and spray patch material, as the Contractor deems necessary, to heat, hot mill, blend, and place the HIR mix to meet the surface tolerance and surface appearance requirements as specified in the Contract Documents.

For premium mixes, the designer should consider specifying that correcting the existing pavement by cold milling prior to HIR should not result in the existing binder course pavement materials being hot milled and added to the HIR mix.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

CONSTRUCTION SPECIFICATION FOR COLD IN-PLACE RECYCLED MIX

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333-A **Commentary**

333.01 SCOPE

This specification covers the requirements for cold in-place recycling of existing hot mix asphalt (HMA) pavement; sizing; adding corrective aggregate or active filler or both, if required; adding and mixing of emulsified asphalt; and spreading and compacting the cold in-place recycled (CIR) mix.

333.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

333.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

333.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 310 Hot Mix Asphalt

Ontario Provincial Standard Specifications, Material

OPSS 1003 Aggregates - Hot Mix Asphalt
OPSS 1103 Emulsified Asphalt
OPSS 1301 Cementing Materials

Ontario Ministry of Transportation Publications

MTO Laboratory Testing Manual:
LS-200 Penetration of Bituminous Materials
LS-291 Quantitative Extraction of Asphalt Cement and Mechanical Analysis of Extracted Aggregate from Bituminous Paving Mixtures - Ontario Procedure
LS-300 Preparation of Marshall Specimens for Cold In-Place Recycled Mixtures
LS-306 Bulk Relative Density of Compacted Bituminous Mixtures Using Paraffin-Coated Specimens
LS-602 Sieve Analysis of Aggregates
LS-625 Sampling of Granular Materials

Ontario Traffic Manual (OTM):
Book 7 - Temporary Conditions

SP-027 Manual for Assessment of Surface Defects of In-Place Recycled Pavement Mats

ASTM International

D 6752 / D 6752M -11 Standard Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Automatic Vacuum Sealing Method

333.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Active Filler means substances added to the reclaimed existing asphalt pavement that chemically alter the mix properties.

AMRL means as defined in OPSS 310.

CCIL means as defined in OPSS 310.

Cold In-Place Recycled (CIR) Mix means the in-place mixture of existing reclaimed HMA pavement, corrective aggregate or active filler or both if required, emulsified asphalt, and water.

Corrective Aggregate means virgin aggregate or reclaimed asphalt pavement (RAP) or both added to the reclaimed existing asphalt pavement to meet the CIR mix design requirements.

Hot Mix Asphalt (HMA) means as defined in OPSS 310.

Quality Assurance (QA) means as defined in OPSS 310.

Quality Control (QC) means as defined in OPSS 310.

Reclaimed Asphalt Pavement (RAP) means as defined in OPSS 310.

Segregation means a condition of the pavement characterized by areas with comparatively coarser or finer texture than that of the surrounding pavement. Longitudinal streak is segregation that manifests itself as a longitudinal mark on the pavement mat.:

a) **Slight Segregation** means the pavement matrix is in place between the coarse aggregate particles; however, there are slightly more coarse aggregate particles in comparison with the surrounding acceptable mix.

b) **Medium Segregation** means the pavement has significantly more coarse aggregate particles than the surrounding acceptable mat and usually exhibits some lack of surface matrix. Some coarse aggregate particle to coarse aggregate particle contact may also exist.

c) **Severe Segregation** means the pavement appears very coarse, predominantly with coarse aggregate particle to coarse aggregate particle contact and the pavement has little or no matrix.

Target Density means the average Bulk Relative Density for the lot established according to LS-300, and used to determine the per cent Compaction.

333.04 DESIGN AND SUBMISSION REQUIREMENTS

333.04.01 Design Requirements

For mix design purposes, prior to commencing the work samples representative of the material that is

produced during the milling operation shall be obtained. These samples shall be used to establish the design rate of emulsified asphalt as a percent by mass of the RAP. The design rate of the emulsified asphalt shall be a minimum of 1.2%.

The mix design shall be completed by a laboratory with CCIL Type A certification or equivalent equipped to carry out CIR mix design. When the existing pavement significantly changes composition, a separate mix design shall be completed.

Each mix design shall include the following:

a) Information on the type, manufacturer, and supplier of the emulsified asphalt.

b) The percent by mass of emulsified asphalt in the CIR, referred to as the design rate, and all calculations performed to determine the design rate of the emulsified asphalt.

c) The optimum moisture content and the mix design bulk relative density.

d) The amount of water to be added to the mix.

e) Maximum field rate adjustment allowed to the design rate without adverse affects to the mix properties.

f) Recovered penetration for the binder of the existing pavement according to LS-200.

g) Type, source, gradation, and quantity of corrective aggregate, if required.

h) Type, source, and quantity of active filler, if required.

333.04.02 Submission Requirements

The mix design shall be submitted to the Contract Administrator a minimum of 7 Days prior to the start of CIR operations. When more than one mix design is required, the area for which each mix design is to be used shall be clearly identified.

A new mix design shall be submitted when the emulsified asphalt design rate is adjusted by greater than 0.2%. Separate or new mix designs shall be submitted if the composition or layer thicknesses or both of the existing pavement changes significantly.

333.05 MATERIALS

333.05.01 Active Filler

If required by the mix design, active filler shall be incorporated into the reclaimed existing asphalt pavement at the application rate determined by the mix design.

When used as active filler, Portland cement shall be according to OPSS 1301. No more than 1% by mass of Portland cement shall be added to the mix.

333.05.02 Corrective Aggregate

If required by the mix design, corrective aggregate shall be incorporated into the reclaimed existing asphalt pavement at the application rate determined in the mix design. Corrective aggregate shall meet the physical and consensus property requirements of OPSS 1003 for the coarse and fine aggregates of Superpave 19.0 binder course.

333.05.03 Emulsified Asphalt

Emulsified asphalt shall be mixing grade meeting the requirements of OPSS 1103, and be compatible with the process and materials used. The addition of polymer modification shall be as specified in the Contract Documents.

333.05.04 Reclaimed Asphalt Pavement

RAP material shall be 100% passing the 37.5 mm sieve and 95 to 100% passing the 26.5 m sieve after processing, as per LS-602.

333.05.05 Water

Water shall be clean and free from oil, acid, alkali, organic matter, or other deleterious substances.

333.06 EQUIPMENT

333.06.01 Recycling Train

The recycling train shall include the following:

a) A self-propelled cold milling unit with a cutting drum capable of reclaiming a full lane width of asphalt pavement to the depth specified in the Contract Documents in one pass.

b) A sizing unit capable of processing the RAP to meet the requirements of this specification.

c) An aggregate feed system that measures and regulates the mass of RAP being added into the mixing unit prior to the addition of the emulsified asphalt. The scale shall be calibrated to the manufacturer's tolerance at the start of the Contract and when requested by the Contract Administrator.

d) An emulsified asphalt control system equipped with a flow meter calibrated in litres per tonne and a total delivery meter calibrated in litres to continuously maintain the required amount of emulsified asphalt added to within 0.2% by mass of the reclaimed material feed.

e) A means of monitoring and controlling the addition of water.

f) A mixing unit equipped with a device capable of producing a uniform and thoroughly blended CIR mix.

Alternative equipment may be considered subject to approval by the Contract Administrator and demonstration of meeting the requirements of the Cold In-Place Recycling Trial Section subsection.

333.06.02 Placing Equipment

Placing of the CIR mix shall be carried out by means of a self-propelled mechanical paver capable of spreading the mix evenly in front of the screed in one continuous pass to the specified crossfall and grade. The paver shall be equipped with distributing augers for the full width to be paved. The paver shall have a vibratory screed capable of vibrating the full width of mix placed.

333.06.03 Compaction Equipment

Appropriate compaction equipment to achieve the required compaction shall be used.

333.06.04 Drying Unit

A drying unit specifically designed to provide radiant heat to the CIR mat may be used. Open flame heating shall not be used. The entire heater assembly shall be capable of readily adjusting the intensity of heat on the pavement surface.

333.06.05 Pilot Vehicle

The pilot vehicle shall be according to the requirements of the OTM, Book 7.

333.06.06 Straight Edge

The straight edge shall be 3 m in length, metal, and have a level recessed in its upper edge parallel to the lower edge.

333.07 CONSTRUCTION

333.07.01 General

HMA pavement in areas inaccessible to the reclaiming equipment shall be removed and replaced with acceptable binder course HMA. The HMA shall be placed to the CIR depth specified in the Contract Documents in compacted lift thicknesses between 40 and 75 mm in depth.

The overlap between successive passes of the recycling train shall be a minimum 100 mm.

333.07.02 Operational Constraints

The work shall not be carried out when the ambient temperature is less than 10 °C or when the overnight low is forecast to be less than 2 °C. CIR shall not be placed after September 1st without written approval from the Contract Administrator. The work shall be carried out when the roadway is clean and free of standing water. CIR shall not proceed in the rain.

All traffic, including construction traffic, shall be kept off the freshly placed CIR mat until it is able to carry traffic without damage. Damaged CIR mat shall be repaired.

The wearing surface shall not be placed on the CIR mat until the following requirements have been met:

a) The CIR mat has been opened to traffic and allowed to cure for a minimum of 14 Days.

b) The specified moisture content has been achieved according to the Acceptance Criteria for Moisture Content subsection.

c) The specified density has been achieved according to the Compaction subsection.

d) All defective areas in the CIR mat have been repaired to the satisfaction of the Contract Administrator.

The wearing surface shall be placed within 30 Days of placing the CIR mat. The 30 Day requirement may be waived by the Contract Administrator if the CIR mix does not meet the requirements of this specification and is subject to repair.

333.07.03 Cold In-Place Recycling Trial Section

Prior to carrying out CIR on the Contract, the ability to successfully carry out CIR according to this specification shall be demonstrated to the Contract Administrator by placing a trial section within the Contract limits.

In lieu of a trial section, the Contract Administrator may accept evidence that the Contractor has demonstrated the ability to successfully mix, handle, place, and compact CIR with the same equipment, placing crew, and methodology to meet the Contract requirements for placing CIR on any Contract within the last 12 months.

The trial section shall be one lane width and 500 m in length. The location of the trial section shall be proposed to the Contract Administrator for approval. The Contract Administrator shall be given a minimum of 48 hours' notice prior to placing the trial section.

The Contract Administrator shall allow the CIR work to continue based on an acceptable visual assessment of the trial according to the requirements of the Surface Appearance subsection. When the CIR is rejected by visual assessment, additional trial sections shall be completed until the CIR meets the requirements of this specification.

Unacceptable trial sections shall be repaired, removed, or replaced, as required.

333.07.04 Surface Preparation

When specified in the Contract Documents, milling prior to CIR work shall be carried out to achieve the specified crossfall and grade.

All deleterious and loose milled material shall be removed from the milled surfaces at longitudinal and transverse joints after reclaiming operations are completed and before placing the CIR mix.

All existing crack sealant shall be removed and disposed of prior to CIR reclaiming operations.

333.07.05 Mixing

The emulsified asphalt shall be added at the design rate. The rate of addition of emulsified asphalt shall be field adjusted as required to within 0.20% of the design rate and mixed to produce a uniformly coated CIR mix that can be compacted to the specified density. The minimum percent of emulsified asphalt added shall be 1.2%

Water may be added in a controlled manner to facilitate uniform mixing.

333.07.06 Compaction

The CIR mix shall be compacted according to the requirements of the Acceptance Criteria for Compaction subsection.

333.07.07 Surface Appearance

The compacted CIR mat shall be smooth and shall be according to the crossfall and grade specified in the Contract Documents. The surface of the CIR mat shall be of uniform texture and shall be free of segregation, longitudinal streaks, flushing, fat spots, oil spills, roller marks, and other defects.

333.07.08 Drying

Prior to the placement of the wearing surface, a drying unit may be used. Overheating or burning of the CIR shall not be allowed.

333.07.09 Sampling

333.07.09.01 General

Holes resulting from the removal of samples shall be repaired according to the sampling provisions of OPSS 310, using acceptable binder course HMA or other material approved by the Contract Administrator.

333.07.09.02 Cold In-Place Recycling Material

At least 4 Business Days prior to the planned overlay of the CIR mat, 2 slab samples of the CIR material shall be obtained for each area taken at random locations, as directed by the Contract Administrator:

One slab sample shall be used to test for moisture content and the other shall be used to test for compaction. Each slab sample shall be dry cut 150 x 150 mm and removed intact from the CIR mat.

The samples shall be packaged in non-absorptive materials to protect sample integrity, sealed in waterproof containers, appropriately labelled, and delivered in good condition within 48 hours of sampling to the designated QA testing laboratory specified in the Contract Documents.

Additional slab samples to test for compaction and moisture content shall only be taken once remedial work has been carried out to improve compaction in the failed areas. The Contractor shall be charged the cost of additional testing.

At the start of production for each location in a Contract, or whenever the existing pavement material significantly changes composition within a location in a Contract, 15 kg of material reclaimed from the roadway after adding emulsion shall be obtained for the purpose of determining target density. Samples shall be taken at random locations as directed by the Contract Administrator.

The Contractor shall be permitted to carry out QC sampling and testing of the CIR mat.

333.07.09.03 Emulsified Asphalt

For information purposes, samples of emulsified asphalt used in the mix shall be taken at the job site from each tanker load of material used on the Contract. Each sample shall be taken either from a sampling spigot on the transfer line, if available, or from the end of the transfer line after a minimum of 4,000 kg has been drawn from the tanker. Each set of samples shall be a minimum of 2 full four-litre containers.

Samples of the emulsified asphalt used in the mix shall be obtained, properly labelled and identified, and delivered to the designated QA testing laboratory.

The sample containers supplied by the Contractor shall be new triple tight epoxy lined pails or suitable leak-proof plastic containers. The sample labels shall be obtained from the Contract Administrator.

333.07.09.04 Corrective Aggregate

The Contract Administrator may request samples of the corrective aggregate to demonstrate conformance to the requirements of this specification. When requested, two 25 kg samples shall be taken in the presence of the Contract Administrator.

QA samples shall be taken in accordance with the procedures given in LS-625 and at the time and location determined by the Contract Administrator.

Samples of the corrective aggregate shall be obtained, properly labeled and identified, and delivered within 48 hours of sampling to the designated QA testing laboratory as specified in the Contract Documents.

333.07.09.05 Active Filler

The Contract Administrator may take samples of active filler to demonstrate conformance to the requirements of this specification.

333.07.10 Traffic Convoy

Traffic shall be convoyed according to the OTM, Book 7.

The pilot vehicle shall guide one-way traffic through or around construction. The maximum speed of the convoy shall be 30 km/h. Convoying shall be maintained until such time as the CIR mat is able to carry traffic without damage.

333.07.11 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

333.08 QUALITY ASSURANCE

333.08.01 General

Acceptance shall be based on QA testing. QA testing shall be carried out at a laboratory currently certified by CCIL with Type A or Type B certification or AMRL accredited or equivalent laboratory.

The Contract Administrator shall reject all unacceptable material and all visually defective material, mix, or work shown in Table 1. Defective material, mixture, and work shall not be incorporated into the finished work.

If the CIR does not meet the requirements of the specification within 30 Days after placing the CIR mat, it shall be deemed unacceptable.

333.08.02 Surface Tolerance

After compaction, the surface of the CIR mat shall be free from deviations exceeding 6 mm, as measured in any direction with a 3 m straight edge.

333.08.03 Acceptance Criteria for Moisture Content

Acceptance criteria shall be based on the QA test results for each location in the Contract.

The moisture content shall be determined according to LS-291. The average moisture content for each location in a Contract placed shall be 2.0% or less, with no individual test for the location exceeding 3.0%.

The CIR mix that does not meet moisture content requirements shall be deemed unacceptable.

333.08.04 Acceptance Criteria for Compaction

Acceptance criteria shall be based on the QA test results for each area represented by a set of slab samples and the Target Density established for that area.

The CIR mix shall be compacted to a minimum of 96% of the Target Density.

Compaction shall be calculated for area of CIR represented by a set of slab sample from the bulk relative density determined from slab samples according to LS-306 or ASTM D 6752 and the Target Density as follows:

Compaction = (bulk relative density of slab sample / Target Density) x 100%

The Target Density shall be established according to LS-300.

CIR that is not compacted to the required density shall be deemed unacceptable.

333.08.05 Acceptance of Corrective Aggregate

QA testing shall be carried out to ensure that corrective aggregate to be used in the work is according to the physical and consensus property requirements of OPSS 1003 for the coarse and fine aggregates of Superpave 19.0 binder course.

333.08.06 Repair of Unacceptable Cold In-Place Recycled Mat

The CIR mat that is unacceptable shall be repaired as specified in Table 1.

Repairs shall be for the full lane width and a minimum length of 15 m to the depth shown in Table 1.

The HMA required to repair unacceptable CIR shall be placed in compacted lift thickness between 40 to 75 mm.

The HMA mix type and design used for repairs shall be approved by the Contract Administrator and shall meet the acceptance requirements for the HMA specified elsewhere in the Contract Documents.

333.09 MEASUREMENT FOR PAYMENT

333.09.01 Actual Measurement

333.09.01.01 Cold In-Place Recycled Mix

Measurement of CIR placed shall be by area in square metres.

333.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

333.10 BASIS OF PAYMENT

333.10.01 Cold In-Place Recycled Mix - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.
The addition of corrective aggregate or active filler to the mix shall be at no extra cost to the Owner.

HMA required to replace unacceptable CIR material shall be at no extra cost to the Owner.

Emulsified asphalt shall be included in the Cold In-Place Recycled Mix item.

Repair of an unacceptable CIR mat shall be carried out at no extra cost to the Owner.

HMA placed in areas inaccessible to the reclaiming equipment shall be included in the Cold In-Place Recycled Mix item.

Repair of areas of CIR damaged by traffic shall be completed at no extra cost to the Owner.

Repair, removal, or replacement of an unacceptable trial section shall be completed at no extra cost to the Owner.

TABLE 1
Unacceptable CIR Mix and Required Repair

Defect Type	Severity	Required Repair
Ravelling/Coarse Aggregate Loss (Note 1)	Very Slight to Slight	No action required.
	Moderate to Severe	Mill 50 mm and replace with an acceptable binder course HMA (Note 3).
	Very Severe	Remove CIR to full depth and replace with an acceptable binder course HMA (Note 3).
Segregation (Note 2)	Slight to Medium	No action required.
	Severe	Mill 50 mm and replace with an acceptable binder course HMA (Note 3).
Moisture content could not be achieved as per the Acceptance Criteria for Moisture Content subsection.	N/A	Remove CIR material to full depth represented by the test and replace with an acceptable binder course HMA (Note 3).
Compaction could not be achieved as per the Acceptance Criteria for Compaction subsection.	N/A	Remove CIR material to full depth represented by the test and replace with an acceptable binder course HMA (Note 3).

Notes:

1. Defect and severity definitions according to SP-027.
2. Defect and severity definitions according to Definitions section of this specification.
3. Reprocessing may be considered as a repair method, upon submission of a proposal by the Contractor and approved by the Contract Administrator.

Appendix 333-A, November 2015
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

Cold in-place recycling (CIR) is suitable for treating a wide range of pavement distresses. CIR can repair pavements exhibiting age, thermal, fatigue, or reflective cracking and previously recycled pavements and is beneficial in mitigating reflective cracking. CIR is not suitable for pavements with extensive base or subbase problems, pavements containing steel slag, or pavements of insufficient strength.

The designer should specify the following in the Contract Documents:

- The addition of polymer modified may be considered to enhance additional performance (333.05.03)

- Depth of CIR. (333.07.01)

- Crossfall and grade. (333.07.07)

- Testing laboratory to carry out CIR moisture content and compaction testing. (333.07.09.02)

- Testing laboratory to carry out corrective aggregate testing. (333.07.09.04)

The designer should determine if the following is required and, if so, specify it in the Contract Documents:

- Additional items for milling or padding or both if significant crossfall deficiencies (> 1%) exist in the existing pavement surface. (333.07.04)

It is recommended that adequate pre-engineering be carried out on the project and that existing pavement thicknesses and composition be established. Additional investigation should be carried out where pavement composition changes, such as patched areas. Pre-engineering data should be included in the Contract Documents.

Corrective aggregates are used when existing pavements are experiencing rutting, shoving, or flushing and it is suspected that the existing bituminous material is the cause of these distresses. Corrective aggregate may also be required to achieve mix design properties.

Any full depth repairs required for frost heave and distortion corrections should be repaired prior to CIR.

In urban areas, the designer should be aware of appurtenance adjustment requirements, curb heights, and accessibility concerns to accommodate the CIR equipment train and the requirement for traffic detours.

Contract scheduling should allow for CIR and follow-up paving to be completed within the time, temperature, and operational constraints.

The designer should be aware that severe distresses (e.g., significant alligator cracking, map cracking) may create an abundance of oversize material and remediation (e.g., pre-milling, pre-pulverizing) that may need to be addressed to meet gradation requirements.

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The designer should be aware that the length of CIR paving operation may affect traffic management.

CIR treatment depths typically range from 75 to 125 mm. The depth of CIR treatment shall be selected to minimize disturbance of the underlying granular base. It is recommended to have at least 25 mm of remaining HMA pavement below the CIR.

CIR is typically overlaid with HMA wearing course. Surface treatment, slurry surfacing, or microsurfacing may be considered.

A tack coat is recommended prior to paving HMA wearing course.

QC requirements have been removed from this specification, as acceptance is based on QA testing. If an Owner requires Contractor QC to confirm that the work meets the specification requirements, a special provision detailing the required Contractor QC should be included in the Contract Documents.

The payment clause for this specification is all inclusive. Should a municipality desire to pay for corrective aggregate, active filler, or emulsified asphalt separately, separate payment items are required.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

CONSTRUCTION SPECIFICATION FOR COLD RECYCLED MIX

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D 334-A **Commentary**

334.01 SCOPE

This specification covers the requirements for a cold mix paving process incorporating reclaimed asphalt pavement (RAP) from stockpiles. The process includes production and processing of RAP, design and testing, placement, and compaction.

334.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be as specified in the Contract Documents.

334.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

334.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 310 Hot Mix Asphalt
OPSS 313 Hot Mix Asphalt - End Result

Ontario Provincial Standard Specifications, Material

OPSS 1102 Liquid Asphalt
OPSS 1103 Emulsified Asphalt

Ministry of Transportation Publications

SP-027 Manual for Assessment of Surface Defects of In-Place Recycled Pavement Mats

Field Guide for the Acceptance of Hot Mix and Bridge Deck Waterproofing

MTO Laboratory Testing Manual:
LS-291 Quantitative Extraction of Asphalt Cement and Mechanical Analysis of Extracted Aggregate from Bituminous Paving Mixtures - Ontario Procedure
LS-300 Preparation of Marshall Specimens for Cold In-Place Recycled Mixture
LS-306 Bulk Relative Density of Compacted Bituminous Mixtures Using Paraffin-Coated Specimens

Ontario Traffic Manual (OTM):
Book 7 - Temporary Conditions

334.03 DEFINITIONS

For the purposes of this specification, the following definitions apply:

CCIL means the Canadian Council of Independent Laboratories

Cold Recycled Mix (CRM) means a mix of processed RAP and asphalt modifier produced through a cold mixing process.

Foreign matter means anything other than hot mix aggregate or granular aggregate.

Hot Mix Asphalt (HMA) means hot mixed, hot laid asphaltic concrete. The terms are used interchangeably. HMA may include recycled or specialty mixes.

Reclaimed Asphalt Pavement (RAP) means the processed HMA material that is recovered by partial or full-depth removal.

334.04 DESIGN AND SUBMISSION REQUIREMENTS

334.04.01 Design Requirements

Prior to commencing the work, for mix design purposes, the Contractor shall obtain RAP samples that are representative of the material to be processed. These samples shall be used to establish the design rate of the asphalt modifier as a percentage by mass of the RAP. The design rate of the asphalt modifier shall be a minimum of 1.2%.

The mix design shall be completed by a laboratory with either CCIL Type A certification or equivalent. Each mix design shall include the following:

a) Information on the type, manufacturer, and supplier of the asphalt modifier.

b) A copy of the mix design and all calculations performed to determine the mix design.

c) All calculations performed to determine the design rate of asphalt modifier.

d) Maximum field rate adjustment allowed to the design rate without adverse affects to mix properties.

334.04.02 Submission Requirements

The mix design shall be submitted to the Contract Administrator a minimum of 7 Days prior to the start of CRM operations.

A new mix design shall be submitted when the asphalt modifier design rate is adjusted by greater than 0.5%. A new mix design shall be submitted if the composition of the existing RAP changes significantly.

334.05 MATERIALS

334.05.01 Reclaimed Asphalt Pavement

The processing operation shall ensure that 100% of the RAP aggregate passes the 26.5 mm sieve. The amount of RAP aggregate passing the 75 µm sieve shall not exceed 15% by mass. Adequate measures shall be taken to manage the RAP source to ensure consistency and prevent contamination.

RAP containing steel slag or asbestos is not permitted. RAP that has become mixed with foreign matter of any description shall not be used.

334.05.02 Asphalt Modifier

The asphalt modifier shall be emulsified asphalt or liquid asphalt as specified in the Contract Documents.

Emulsified asphalt shall meet the requirements of OPSS 1103 and be either a mixing grade polymer modified high float emulsified asphalt or a mixing grade high float emulsified asphalt, as specified in the Contract Documents.

Liquid asphalt shall be according to OPSS 1102.

334.06 EQUIPMENT

334.06.01 Production and Processing Equipment

Crushing or milling equipment and screening equipment shall be used to generate and process the RAP to the size specified in the mix design. Material shall be handled in such a way as to prevent recompaction of the material before mixing takes place.

334.06.02 Mixing Equipment

The mixing unit shall be capable of producing a uniform thoroughly blended CRM consisting of RAP and asphalt modifier. The RAP feed system to the mixing unit shall be equipped with a means of determining the mass of material being deposited into the mixing unit prior to the addition of the asphalt modifier. The mixing unit shall be capable of continuously maintaining the amount of asphalt modifier added within ± 0.2% by weight of the RAP. All measuring devices shall be calibrated according to the manufacturer's specifications at the start of the Contract and whenever deemed necessary by the Contract Administrator.

The asphalt modifier supply system shall identify and display flow and delivery information.

334.06.03 Placing Equipment

Placing of the CRM shall be carried out by means of a self-propelled mechanical paver capable of spreading the mix evenly in front of the screed in one continuous pass to the specified crossfall and grade. The paver shall be equipped with distributing augers for the full width to be paved. The paver shall have a vibratory screed capable of vibrating the full width of mix placed.

334.06.04 Compaction Equipment

The Contractor shall select the appropriate compaction equipment to achieve the required compaction.

334.06.05 Drying Unit

The drying unit shall be specifically designed to provide radiant heat to the CRM mat. Open flame heating shall not be used. The entire heater assembly shall be capable of readily adjusting the intensity of heat on the pavement surface.

334.06.06 Straight Edge

A 3 m commercially made metal straight edge is required. The straight edge shall have a level recessed in its upper surface, parallel to the lower edge.

334.06.07 Pilot Vehicle

The pilot vehicle shall be according to the requirements of the OTM, Book 7.

334.07 CONSTRUCTION

334.07.01 Operational Constraints

The placing of CRM shall not be carried out when the ambient temperature is less than 10 °C or when the overnight low is forecast to be less than 2 °C. After September 1st, written approval must be obtained from the Contract Administrator prior to CRM paving.

The work shall be carried out when the roadway is clean and free of standing water. CRM shall not proceed during periods of rain.

The wearing surface shall not be placed on the CRM mat until the following requirements have been met:

a) The CRM mix has been allowed to cure for a minimum of 14 Days. The curing period may be shortened with the approval of the Contract Administrator.

b) The average in situ moisture content of the CRM is 2% or less with no test value greater than 3% immediately prior to placing the wearing surface.

c) The specified density has been achieved.

d) All defective areas in the CRM mat have been repaired to the satisfaction of the Contract Administrator.

The wearing surface shall be placed within 30 Days of placing the CRM mat, provided the CRM mix meets the requirements of this specification.

All traffic, including construction traffic, shall be kept off the freshly placed CRM mat until it is able to carry traffic without damage. The Contractor shall be responsible for repair of the damaged CRM mat.

334.07.02 Mixing

The asphalt modifier shall be added at the design rate. The rate of addition of asphalt modifier may be adjusted as required to within 0.5% of the design rate or to the maximum field rate adjustment of the design rate allowed according to the mix design, whichever is less, to produce a uniformly coated CRM mix that can be compacted to the required density.

334.07.03 Compaction

The CRM shall be compacted to a minimum of 96% of the laboratory bulk relative density as determined by the submitted mix design, according to LS-300.

CRM that cannot be compacted to the required density shall be removed and replaced according to Table 1.

334.07.04 Surface Appearance

The compacted CRM surface shall be smooth and conform to the crossfall and grade specified in the Contract Documents. The surface of the CRM mat shall be of uniform texture and free of segregation, longitudinal streaks, fat spots, oil spills, roller marks, and other defects.

334.07.05 Drying

Prior to the placement of the wearing surface, the Contractor may elect to use a drying unit. Overheating or burning of the CRM shall not be allowed.

334.07.06 Sampling

334.07.06.01 General

The Contract Administrator may apply security seals to the samples taken for Quality Assurance (QA) testing.

All samples, including those handled by a commercial carrier, shall be accompanied by a sample data sheet and any additional documents as specified elsewhere in the Contract Documents. When not specified or not included on the sample data sheet, samples shall be delivered with a transmittal form identifying the following information:

a) Contract Number.

b) Name of Contractor, name of contact person and telephone numbers.

c) Name of Contract Administrator, and telephone numbers.

d) Quantity and type of sample. When a sample consists of more than one item, each item shall be individually identified.

e) Date sampled.

f) Date shipped.

g) Sample, lot and sublot number.

h) Sample location.

The Contractor may carry out quality control sampling and testing of the CRM mat.

Holes resulting from the removal of samples shall be repaired according to the sampling provisions of OPSS 310 or OPSS 313, as appropriate to the Contract, using surface course HMA or other material approved by the Contract Administrator.

334.07.06.02 Compaction

After initial compaction, a minimum of three samples of the compacted CRM shall be obtained by the Contractor, at random locations as determined by the Contract Administrator, for each full day or partial day of production. These samples shall be used for compaction testing.

Samples shall be removed intact from the pavement in sufficient quantities to carry out testing according to the MTO Laboratory Testing Manual.

334.07.06.03 Moisture Content

At least 4 Business Days prior to the planned overlay of the CRM mat, the Contractor shall obtain 2 slab samples of the CRM mix for each sublot taken at random locations, as directed by the Contract Administrator.

The moisture content shall be determined in accordance with LS-291. The Contractor shall test one of the duplicate samples and the other shall be delivered to the testing laboratory designated in the Contract Documents.

Each sample shall be dry cut 150 x 150 mm and removed intact from the pavement. It shall be packaged to protect sample integrity, appropriately labelled, sealed in waterproof containers, and delivered by the Contractor in good condition to the designated testing laboratory within 24 hours of sampling.

If a sample condition is found to be unsuitable for testing by the laboratory, the Contractor shall be notified immediately by the Contract Administrator to resample that location.

334.07.06.04 Asphalt Modifier

Samples of the asphalt modifier used in the mix, shall be obtained, labelled, properly identified, and delivered within 5 Business Days of sampling to the testing laboratory designated in the Contract Documents. Each sample of material shall be a minimum of 2 full four-litre containers.

Samples shall be taken at the job site from each tanker load of material. Each sample shall be taken after a minimum of 4,000 kg has been drawn from the tanker, from a sampling spigot on the transfer line, if available, or from the end of the transfer line.

The sample containers supplied by the Contractor shall be new triple tight epoxy lined pails or suitable leak-proof plastic containers. The sample labels shall be obtained from the Contract Administrator.

334.07.07 Traffic Convoy

When specified in the Contract Documents, the Contractor shall convoy traffic according to the OTM, Book 7.

The pilot vehicle shall guide one-way traffic through or around construction. The maximum speed of the convoy shall be 30 km/h. Convoying shall be maintained until such time as the CRM mat is able to carry traffic without damage.

334.07.08 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

334.08 QUALITY ASSURANCE

334.08.01 General

The Contract Administrator shall reject all visually defective material, mix, or work according to Table 1. Such defective material, mixture, and work shall not be incorporated into the finished work.

QA testing shall be carried out at a laboratory currently certified by CCIL with Type A or Type B certification or equivalent. Samples shall be used to determine compliance for moisture content and compaction. Acceptance criteria shall be based on the lot mean computed from QA test results for each sublot within the lot.

If a tested sample fails to meet the Contract requirements, the Contractor shall be notified of the failure by the Contract Administrator within 24 hours of the Contract Administrator receiving the information.

334.08.02 Lot Size

A lot shall consist of a single day's production of CRM processed to a given mix design. Each lot shall be divided into a minimum of 3 equal sublots of 5,000 m^2 or smaller.

334.08.03 Surface Tolerance

After compaction, the surface of the CRM mat shall be free from deviations exceeding 6 mm, as measured in any direction with a 3 m straight edge.

334.08.04 Acceptance Criteria for Moisture Content

The moisture content shall be determined according to LS-291. The mean moisture content for each lot shall be less than 2.0% with no sublot moisture content exceeding 3.0%.

334.08.05 Acceptance Criteria for Compaction

The compaction of the CRM mix shall be determined according to LS-306. Each lot of CRM mix shall be compacted to a minimum mean of 96.0% of the target density established for the mix with no sublot result falling below 95.0%.

334.08.06 Asphalt Modifier

The supplied emulsified asphalt samples shall be according to OPSS 1103 for the particular type and grade, when tested according to the test methods specified.

The supplied liquid asphalt samples shall meet the requirements of OPSS 1102 for the particular type and grade, when tested according to the test methods specified.

Failure of the sample to conform to any of the material requirements shall be cause for rejection of the material. The CRM that has incorporated asphalt modifier represented by the failed test result shall be unacceptable and remedial measures up to and including removal and replacement of the deficient mix shall be negotiated with the Contract Administrator.

334.08.07 Repair of Unacceptable Cold Recycled Mix Mat

The CRM mat that is unacceptable shall be repaired or removed and replaced as specified in Table 1. Repairs shall be for the full width of recycling to the depth specified in Table 1. Removal shall be for the full depth and lane width of recycling. Reprocessing may be considered as a repair method, upon submission of a proposal by the Contractor and approval by the Contract Administrator.

334.09 MEASUREMENT FOR PAYMENT

334.09.01 Actual Measurement

334.09.01.01 Cold Recycled Mix

Measurement of the CRM placed shall be by area in square metres.

334.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clause under Actual Measurement.

334.10 BASIS OF PAYMENT

334.10.01 Cold Recycled Mix - Item

Payment at the Contract price for the above items shall be full compensation for all labour, Equipment, and Material to do the work.

Asphalt modifier is included in the cold recycled mix item.

Samples found to be unsuitable for testing upon delivery to the laboratory shall be resampled at no cost to the Owner.

Repair to or removal and replacement of unacceptable CRM mat shall be carried out at no cost to the Owner.

HMA required to replace unacceptable CRM material shall be at no cost to the Owner.

TABLE 1
Unacceptable CRM Mix and Required Repairs

Deficiency Type	Severity	Required Repair
Ravelling/Coarse Aggregate Loss (Note 1)	Very Slight to Slight	No action required.
	Moderate to Severe	Mill 50 mm and replace with same HMA to be used on surface course or an acceptable HMA as specified in the Contract Documents.
	Very Severe	Remove all CRM material and replace with same HMA to be used on surface course or an acceptable HMA as specified in the Contract Documents.
Segregation (Note 2)	Slight to Medium	No action required.
	Severe	Mill 50 mm and replace with same HMA to be used on surface course or an acceptable HMA as specified in the Contract Documents.
Moisture content could not be achieved as per the Acceptance Criteria for Moisture Content subsection.	N/A	Remove all CRM material in the sublot represented by the test and replace with CRM or the same HMA to be used on surface course or an acceptable HMA as specified in the Contract Documents.
Compaction could not be achieved as per the Acceptance Criteria for Compaction subsection.	N/A	Remove all CRM material in the sublot represented by the test and replace with CRM or the same HMA to be used on surface course or an acceptable HMA as specified in the Contract Documents.

Notes:

1. Deficiency and severity definitions according to SP-027.

2. Deficiency and severity definitions according to Field Guide for the Acceptance of Hot Mix and Bridge Deck Waterproofing.

A. The HMA shall be placed in compacted lift thicknesses between 40 and 75 mm.

Appendix 334-A, November 2016
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Type of asphalt modifier (i.e., emulsified asphalt or liquid asphalt modifier). (334.05.02)

- Type of wearing surface. (334.07.01)

- Crossfall and grade. (334.07.04)

- Location of testing laboratory. (337.07.06.01, 334.07.06.02, 334.07.06.03, 334.07.06.04)

- Replacement HMA to be used. (334.08.07)

The designer should determine if the following is required and, if so, specify it in the Contract Documents:

- The emulsified asphalt as either a mixing grade polymer modified high float emulsified asphalt or a mixing grade high float emulsified asphalt. (334.05.02)

- Traffic convoy requirements. (334.07.07)

CRM can be a cost-effective paving material for structural improvement of low volume roads.

CRM is susceptible to moisture intrusion and ravelling, and must be sealed with a wearing surface. Typically, cold recycled mix is overlain with a surface treatment or single lift hot mix overlay. For higher traffic volume application, multiple lifts of hot mix may be considered.

Designer should be aware of when setting up quantities, due to the variability of RAP, field adjustment of the quantity of asphalt modifier may be required.

Currently, there is no standardized mix design methodology for CRM.

Designer should address the issue of RAP ownership and quality of RAP during the preparation of contract specifications. Identify who owns the RAP and who is responsible for RAP quality.

CRM contracts should be tendered to allow for placement in warm summer months to achieve proper curing of the CRM mat.

A single contract incorporating placement of CRM and wearing surface is recommended.

Since payment for the CRM is by the square metre, the designer should ensure that grade preparation is part of the CRM contract.

A tack coat is recommended prior to surfacing CRM with HMA.

When specifying liquid asphalts, the designer should consider the environmental aspects of the product.

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Contract scheduling should allow for CRM paving and follow-up wearing surface placement to be completed within the time and temperature operational constraints.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here

CONSTRUCTION SPECIFICATION FOR COLD IN-PLACE RECYCLED EXPANDED ASPHALT MIX

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335-A **Commentary**

335.01 SCOPE

This specification covers the requirements for cold in-place recycling of existing hot mix asphalt (HMA) pavement; sizing; adding corrective aggregate or active filler or both, if required; adding and mixing expanded asphalt; and spreading and compacting the cold in-place recycled expanded asphalt mix (CIREAM).

335.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

335.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

335.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 310 Hot Mix Asphalt

Ontario Provincial Standard Specifications, Material

OPSS 1003 Aggregates - Hot Mix Asphalt
OPSS 1101 Performance Graded Asphalt Cement
OPSS 1301 Cementing Materials

Ontario Ministry of Transportation Publications

MTO Laboratory Testing Manual:
LS-200 Penetration of Bituminous Materials
LS-297 Determination of Indirect Tensile Strength of Expanded Asphalt Mixes
LS-306 Bulk Relative Density of Compacted Bituminous Mixtures Using Paraffin-Coated Specimens
LS-625 Sampling of Granular Materials
SP-027 Manual for Assessment of Surface Defects of In-Place Recycled Pavement Mats

Ontario Traffic Manual (OTM):
Book 7 - Temporary Conditions

ASTM International

D 6752-09 Standard Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Automatic Vacuum Sealing Method

Wirtgen GmbH Publication

Wirtgen Cold Recycling Technology manual, 3rd edition, 2010

335.03 DEFINITIONS

For the purpose of this specification, definitions shall be as per SP-027.

335.04 DESIGN AND SUBMISSION REQUIREMENTS

335.04.01 Design Requirements

For mix design purposes, prior to commencing the work the Contractor shall obtain samples representative of the material that is produced during the milling operation. These samples shall be used to establish the design rate of expanded asphalt as a percent by mass of the RAP. The design rate of the expanded asphalt shall be a minimum of 1.0%. The dry tensile strength shall be a minimum of 225 kPa and the wet tensile strength shall be a minimum of 100 kPa. The tensile strength ratio shall be a minimum of 50%.

The mix design shall be carried out according to the Wirtgen Cold Recycling Technology manual using briquettes produced according to LS-297. Mix design work shall be completed by a laboratory with CCIL Type A certification or equivalent equipped to carry out expanded asphalt mix design. When the existing pavement significantly changes composition, a separate mix design shall be completed.

Each mix design shall include the following:

a) Information on the grade, manufacturer, and supplier of the PGAC.

b) The percent by mass of expanded asphalt in the CIREAM, referred to as the design rate, and all calculations performed to determine the design rate of the expanded asphalt.

c) The recommended PGAC temperature for foaming, the half life, the expansion ratio, and the percent of water added for foaming.

d) The optimum moisture content and the mix design bulk relative density.

e) The dry tensile strength, the wet tensile strength, and the tensile strength ratio.

f) The amount of water to be added to the mix.

g Maximum field rate adjustment allowed to the design rate without adverse affects to the mix properties.

h) Recovered penetration for the binder of the existing pavement according to LS-200.

i) Type, source, gradation, and quantity of corrective aggregate, if required.

j) Type, source, and quantity of active filler, if required.

335.04.02 Submission Requirements

The mix design shall be submitted by the Contractor to the Contract Administrator a minimum of 7 Days prior to the start of CIREAM operations. When more than one mix design is required, the area for which each mix design is to be used shall be clearly identified.

A new mix design shall be submitted when the expanded asphalt design rate is adjusted by greater than 0.2%. Separate or new mix designs shall be submitted if the composition or layer thicknesses or both of the existing pavement changes significantly.

335.05 MATERIALS

335.05.01 Active Filler

If required by the mix design, active filler shall be incorporated into the reclaimed existing asphalt pavement at the application rate determined by the mix design.

When used as active filler, Portland cement shall be according to OPSS 1301. No more than one percent by mass of Portland cement shall be added to the mix.

335.05.02 Corrective Aggregate

If required by the mix design, corrective aggregate shall be incorporated into the reclaimed existing asphalt pavement at the application rate determined in the mix design. Corrective aggregate shall meet the physical and consensus property requirements of OPSS 1003, with the exception of the sand equivalent test, for the coarse and fine aggregates of Superpave 19.0 binder course.

335.05.03 Performance Graded Asphalt Cement

The Contractor shall select a PGAC with suitable expansion characteristics. PGAC shall be according to OPSS 1101, excluding PGAC zone requirements.

335.05.04 Reclaimed Asphalt Pavement

RAP material shall be 100% passing the 37.5 mm sieve and 95 to 100% passing the 26.5 mm sieve after processing.

335.05.05 Water

Water shall be clean and free from oil, acid, alkali, organic matter, or other deleterious substances.

335.06 EQUIPMENT

335.06.01 Recycling Train

The recycling train shall include the following:

a) A self-propelled cold milling unit with a cutting drum capable of reclaiming a full lane width of asphalt pavement to the depth specified in the Contract Documents in one pass.

b) A sizing unit capable of processing the RAP to meet the requirements of this specification.

c) An aggregate feed system that measures and regulates the mass of RAP being added into the mixing unit prior to the addition of the expanded asphalt. The scale shall be calibrated to the manufacturer's tolerance at the start of the Contract and when requested by the Contract Administrator.

d) An asphalt cement expansion system capable of producing optimum expansion and an injection system capable of injecting and blending expanded asphalt uniformly throughout the reclaimed material.

e) A system to control and regulate the application of expanded asphalt in relation to the mass of RAP being processed within a tolerance of $\pm$ 3.0% by volume of asphalt cement.

f) A mixing unit equipped with a device capable of producing a uniform and thoroughly blended CIREAM.

Alternative equipment may be considered subject to approval by the Contract Administrator and demonstration of meeting the requirements of the Cold In-Place Recycled Expanded Asphalt Trial Section subsection.

335.06.02 Placing Equipment

Placing of the CIREAM shall be carried out by means of a self-propelled mechanical paver capable of spreading the mix evenly in front of the screed in one continuous pass to the specified crossfall and grade. The paver shall be equipped with distributing augers for the full width to be paved. The paver shall have a vibratory screed capable of vibrating the full width of mix placed.

335.06.03 Compaction Equipment

The Contractor shall select the appropriate compaction equipment to achieve the required compaction.

335.06.04 Pilot Vehicle

The pilot vehicle shall be according to the requirements of the OTM, Book 7.

335.06.05 Straight Edge

The straight edge shall be 3 m in length, metal, and have a level recessed in its upper edge parallel to the lower edge.

335.07 CONSTRUCTION

335.07.01 General

HMA pavement in areas inaccessible to the reclaiming equipment shall be removed and replaced with acceptable binder course HMA. The HMA shall be placed to the CIREAM depth specified in the Contract Documents in compacted lift thicknesses between 40 and 75 mm in depth.

The overlap between successive passes of the recycling train shall be a minimum 100 mm.

335.07.02 Operational Constraints

CIREAM shall not be placed after September 1st without written approval from the Contract Administrator.

The work shall be carried out when the roadway is clean and free of standing water. CIREAM shall not proceed in the rain.

All traffic, including construction traffic, shall be kept off the freshly placed CIREAM mat until it is able to carry traffic without damage. The Contractor shall be responsible for repair of the damaged CIREAM mat.

The wearing surface shall not be placed on the CIREAM mat until the following requirements have been met:

a) The CIREAM mat has been opened to traffic and allowed to cure for a minimum of 3 Days.

b) The specified tensile strength has been achieved according to the Quality Assurance section.

c) The specified density has been achieved according to the Compaction subsection.

d) All defective areas in the CIREAM mat have been repaired to the satisfaction of the Contract Administrator.

The wearing surface shall be placed within 30 Days of placing the CIREAM mat. The 30 Day requirement may be waived by the Contract Administrator if the CIREAM does not meet the requirements of this specification and is subject to repair.

335.07.03 Cold In-Place Recycled Expanded Asphalt Trial Section

Prior to carrying out CIREAM on the Contract, the Contractor shall demonstrate to the Contract Administrator the ability to successfully carry out CIREAM according to this specification by placing a trial section within the Contract limits.

In-lieu of a trial section, the Contract Administrator may accept evidence that the Contractor has demonstrated the ability to successfully mix, handle, place, and compact CIREAM with the same equipment, placing crew, and methodology to meet the Contract requirements for placing CIREAM on any Contract within the last 12 months.

The trial section shall be one lane width and 500 m in length. The Contractor shall propose the location of the trial section to the Contract Administrator for approval. The Contractor shall give the Contract Administrator a minimum of 48 hours notice prior to placing the trial section.

The Contract Administrator shall allow the Contractor to continue the CIREAM work based on an acceptable visual assessment of the trial according to the requirements of the Surface Appearance subsection. When the CIREAM is rejected by visual assessment, the Contractor shall repeat additional trial sections until the CIREAM meets the requirements of this specification.

The Contractor shall be responsible for the repair, removal, or replacement of an unacceptable trial section.

335.07.04 Surface Preparation

When specified in the Contract Documents, milling prior to CIREAM work shall be carried out to achieve the specified crossfall and grade.

All deleterious and loose milled material shall be removed from the milled surfaces at longitudinal and transverse joints after reclaiming operations are completed and before placing CIREAM.

All existing crack sealant shall be removed and disposed of prior to CIREAM reclaiming operations.

335.07.05 Mixing

The expanded asphalt shall be added at the design rate. The rate of addition of expanded asphalt shall be field adjusted as required to within 0.20% of the design rate and mixed to produce a uniformly coated

CIREAM that can be compacted to the specified density. The minimum percent of expanded asphalt added shall be 1.0%.

335.07.06 Compaction

The CIREAM shall be compacted according to the requirements of the Acceptance Criteria for Compaction subsection.

335.07.07 Surface Appearance

The compacted CIREAM mat shall be smooth and shall be according to the crossfall and grade specified in the Contract Documents. The surface of the CIREAM mat shall be of uniform texture and shall be free of segregation, longitudinal streaks, flushing, fat spots, oil spills, roller marks, and other defects.

335.07.08 Sampling

335.07.08.01 General

Holes resulting from the removal of samples shall be repaired according to the sampling provisions of OPSS 310, using an acceptable binder course HMA or other material approved by the Contract Administrator.

335.07.08.02 Cold In-Place Recycled Expanded Asphalt Mix

After placement and prior to compaction, the Contractor shall obtain one 15 kg sample of the CIREAM from each 5,000 m^2 placed, taken at random locations as directed by the Contract Administrator. The samples to be tested for acceptance of CIREAM shall be used to test for dry tensile strength, wet tensile strength, and tensile strength ratio according to LS-297.

Prior to the planned overlay of the CIREAM mat, the Contractor shall obtain 2 slab samples of the CIREAM from each 5,000 m^2 placed, to be taken at random locations as directed by the Contract Administrator. One slab sample shall be used to test for moisture content and the other shall be used to test for compaction. Each slab sample shall be dry cut 150 x 150 mm and removed intact from the CIREAM mat.

The samples shall be packaged in non-absorptive materials to protect sample integrity, sealed in waterproof containers, appropriately labelled, and delivered by the Contractor in good condition within 48 hours of sampling to the designated QA testing laboratory specified in the Contract Documents.

Additional slab samples to test for compaction shall only be taken once the Contractor has carried out remedial work to improve compaction in the failed areas. The Contractor shall be charged the cost of additional testing.

The Contractor shall be permitted to carry out QC sampling and testing of the CIREAM mat.

335.07.08.03 Corrective Aggregate

The Contract Administrator may request samples of the corrective aggregate to demonstrate conformance to the requirements of this specification. When requested, two 25 kg samples shall be taken in the presence of the Contract Administrator.

QA samples shall be taken in accordance with procedures given in LS-625 and at the time and location determined by the Contract Administrator.

Samples of the corrective aggregate shall be obtained, properly labelled and identified, and delivered within 48 hours of sampling to the designated QA testing laboratory as specified in the Contract Documents.

335.07.08.04 Active Filler

The Contract Administrator may take samples of active filler to demonstrate conformance to the requirements of the Contract Documents.

335.07.09 Traffic Convoy

The Contractor shall convoy traffic according to the OTM, Book 7.

The pilot vehicle shall guide one-way traffic through or around construction. The maximum speed of the convoy shall be 30 km/h. Convoying shall be maintained until such time as the CIREAM mat is able to carry traffic without damage.

335.07.10 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

335.08 QUALITY ASSURANCE

335.08.01 General

Acceptance shall be based on QA testing. QA testing shall be carried out by a laboratory currently certified by CCIL with Type A or Type B certification or AMRL accredited or equivalent laboratory.

Acceptance criteria shall be based on the QA test results for each 5,000 m^2 placed.

The Contract Administrator shall reject all unacceptable material and all visually defective material, mix, or work as shown in Table 1. Defective material, mixture, and work shall not be incorporated into the finished work.

If the CIREAM does not meet the requirements of the specification within 30 Days after placing the CIREAM mat, it shall be deemed unacceptable.

335.08.02 Surface Tolerance

After compaction, the surface of the CIREAM mat shall be free from deviations exceeding 6 mm, as measured in any direction with a 3 m straight edge.

335.08.03 Acceptance Criteria for Compaction

The CIREAM shall be compacted to a minimum of 96% of the target density.

Compaction shall be calculated for each 5,000 m^2 placed from the bulk relative density determined from slab samples according to LS-306 or ASTM D 6752 and the target density as follows:

Compaction = (bulk relative density of the slab sample / target density) x 100%

The target density to be used for acceptance purposes shall be calculated for each 5,000 m^2 placed by averaging the densities of 6 compacted specimens produced for indirect tensile strength testing according to LS-297.

335.08.04 Acceptance Criteria for Cold In-Place Recycled Expanded Asphalt Mix

Acceptance of the CIREAM shall be based on dry tensile strength, wet tensile strength, and tensile strength ratio.

Samples of CIREAM shall be tested for acceptance purposes in accordance with LS-297.

Dry tensile strength requirements for each 5,000 m^2 placed are met when the dry tensile strength of the sample is equal to or greater than 225 kPa.

Wet tensile strength requirements for each 5,000 m^2 placed are met when the wet tensile strength of the sample is equal to or greater than 100 kPa.

The tensile strength ratio for the individual samples shall not be less than 50%.

CIREAM that does not meet the above dry tensile strength, wet tensile strength, and tensile strength ratio requirements shall be deemed unacceptable.

335.08.05 Acceptance of Corrective Aggregate

QA testing may be carried out to ensure that corrective aggregate to be used in the work is according to the physical and consensus property requirements of OPSS 1003, with the exception of the sand equivalent test, for the coarse and fine aggregates of Superpave 19.0 binder course.

335.08.06 Repair of Unacceptable CIREAM

CIREAM that is unacceptable shall be repaired as shown in Table 1.

Repairs shall be for the full lane width and minimum length of 15 m to the depth shown in Table 1.

The HMA required to repair unacceptable CIREAM shall be placed in compacted lift thickness between 40 to 75 mm.

The HMA mix type and design used for repairs shall be approved by the Contract Administrator and shall meet the acceptance requirements for the HMA specified elsewhere in the Contract Documents.

335.09 MEASUREMENT FOR PAYMENT

335.09.01 Actual Measurement

335.09.01.01 Cold In-Place Recycled Expanded Asphalt Mix

Measurement of CIREAM placed shall be by area in square metres.

335.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

335.10 BASIS OF PAYMENT

335.10.01 Cold In-Place Recycled Expanded Asphalt Mix - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour,

Equipment, and Material to do the work.

The addition of corrective aggregate or active filler to the mix shall be at no extra cost to the Owner.

HMA required to replace unacceptable CIREAM material shall be at no extra cost to the Owner.

PGAC shall be included in the CIREAM item.

Repair of unacceptable CIREAM mat shall be carried at no extra cost to the Owner.

HMA placed in areas inaccessible to the reclaiming equipment shall be included in the CIREAM item.

Repair of areas of CIREAM damaged by traffic shall be completed at no extra cost to the Owner.

Repair, removal, or replacement of an unacceptable trial section shall be completed at no extra cost to the Owner.

TABLE 1
Acceptance Criteria and Repair Requirements for CIREAM

Acceptance Criteria	Defect Type	Severity / Criteria	Acceptable / Rejectable	Repair Requirements
Surface Appearance	Ravelling/Coarse Aggregate Loss (Note 1)	Very Slight to Slight	Acceptable	No action required.
		Moderate to Severe	Rejectable	Mill 50 mm and replace with an acceptable binder course HMA (Note 2).
		Very Severe	Rejectable	Remove CIREAM to full depth and replace with an acceptable binder course HMA (Note 2).
	Segregation (Note 1)	Slight to Medium	Acceptable	No action required.
		Severe	Rejectable	Mill 50 mm and replace with an acceptable binder course HMA (Note 2).
	Rutting (Note 1)	Very Slight to Slight	Acceptable	No action required.
		Moderate to Severe	Rejectable	Mill 50 mm and replace with an acceptable binder course HMA (Note 2).
		Very Severe	Rejectable	Remove CIREAM to full depth and replace with an acceptable binder course HMA (Note 2).
Surface Tolerance	Non-conformance for surface tolerance as per the Surface Tolerance subsection of the Acceptance Criteria.	> 6 mm based on 3 m straight edge measurement	Rejectable	All deficient areas shall be re-profiled by milling or padded with the same hot mix type to be used in the overlying hot mix lift.
Compaction	Non-conformance for Compaction as per the Compaction subsection of the Acceptance Criteria.	< 96% for Compaction of Lot's Mean; and < 95% for Compaction of Individual Sublot	Rejectable	For rejected sublots, or sublots within the corresponding rejected lot: 1) Recompact the CIREAM mat, if required, with reheating process, or 2) Reprocess with a recycling train (Note 2), or 3) Remove CIREAM material to full depth and replace with an acceptable binder course HMA.
Tensile Strength	Non-conformance for Tensile Strength as per the Tensile Strength of Cold In-place Recycled Expanded Asphalt Mix subsection of the Acceptance Criteria.	For Dry Tensile Strength: < 225 KPa for Lot's Mean; and < 200 KPa for Individual Sublot. For Wet Tensile Strength: < 100 KPa for Lot's Mean; and < 75 KPa for Individual Sublot.	Rejectable	Remove CIREAM to full depth in the lot or sublot represented by the test and replace with an acceptable binder course HMA (Note 2).

Notes:
1) Defect and severity definitions according to SP-027.
2) Reprocessing with a recycling train may be considered as a repair method, upon submission of a proposal by the Contractor and approved by the Contract Administrator.

Appendix 335-A, Commentary for OPSS.MUNI 335, November 2016
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

Cold in-place recycling with expanded asphalt (CIREAM) is suitable for treating a wide range of pavement distresses. CIREAM can repair pavements exhibiting age; thermal, fatigue, or reflective cracking and previously recycled pavements and is beneficial in mitigating reflective cracking. CIREAM is not suitable for pavements with extensive base or subbase problems, pavements containing steel slag, or pavements of insufficient strength.

The designer should specify the following in the Contract Documents:

- Depth of CIREAM. (335.07.01)

- Grade and crossfall. (335.07.07)

- Designated testing laboratory. (335.07.08.02, 335.07.08.03)

The designer should determine if the following is required and, if so, specify it in the Contract Documents:

- Additional items for milling or padding or both if significant crossfall deficiencies exist in the existing pavement surface. (335.07.04)

It is recommended that adequate pre-engineering be carried out on the project and that existing pavement thicknesses and composition be established. Additional investigation should be carried out when pavement composition changes, such as patched areas. Pre-engineering data should be included in the Contract Documents.

Corrective aggregates are used when existing pavements are experiencing rutting, shoving, or flushing and it is suspected that the existing bituminous material is the cause of these distresses. Corrective aggregate may also be required to achieve mix design properties.

Any full depth repairs required for frost heave and distortion corrections should be repaired prior to CIREAM.

In urban areas, the designer should be aware of appurtenance adjustment requirements, curb heights, and accessibility concerns to accommodate the CIREAM equipment train and the requirement for traffic detours.

Contract scheduling should allow CIREAM and follow-up pavement to be completed within the time and operational constraints.

The designer should be aware that severe distresses (e.g., significant alligator cracking, map cracking) may create an abundance of oversize material and remediation (e.g., pre-milling, pre-pulverizing) needs to be addressed to meet gradation requirements.

The designer should be aware that the length of CIREAM paving operation may affect traffic management.

Appendix 335-A

It is recommended to have at least 25 mm of remaining HMA pavement below the CIREAM.

CIREAM is typically overlaid with a HMA wearing course. Surface treatment, slurry surfacing, or microsurfacing may be considered.

A tack coat is recommended prior to paving HMA wearing course.

QC requirements have been removed from this specification, as acceptance is based on QA testing. If an Owner requires Contractor QC to confirm that the work meets the specification requirements, a special provision detailing the required Contractor QC should be included in the Contract Documents.

The payment clause for this specification is all inclusive. Should a municipality desire to pay for corrective aggregate, active filler, or asphalt cement separately, separate payment items are required.

In times of volatile asphalt cement prices, on multi-year contracts, and on Contracts with greater than 1,000 tonnes of paver laid CIREAM material, designers may consider using the MTO PGAC price index for payment adjustment. The MTO PGAC price index is available on the Ontario Ministry of Transportation website at www.raqs.mto.gov.on.ca, by clicking on Contractor, Contract Bulletin, Asphalt Price Index. The MTO PGAC price index is only a tool for qualifying PGAC prices and is not intended as a standard asphalt cement price to be incorporated into the contract bid. The MTO PGAC price index calculation for a given month takes in the average of the 4 weeks of the month and is published on the last day of the month.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

CONSTRUCTION SPECIFICATION FOR MICRO-SURFACING

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336.01 SCOPE

This specification covers the requirements for micro-surfacing and includes all surface preparation, material application, tack coating, handwork, joints, protection while curing, clean up, and trial area.

336.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be as specified in the Contract Documents.

336.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

336.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 710 Pavement Marking

Ontario Provincial Standard Specifications, Material

OPSS 1001 Aggregates - General
OPSS 1003 Aggregates - Hot Mixed Asphalt
OPSS 1103 Emulsified Asphalt
OPSS 1301 Cementing Materials

Ontario Ministry of Transportation Publications

MTO Laboratory Testing Manual:
LS-200 Penetration of Bituminous Materials
LS-202 Kinematic Viscosity of Asphalt
LS-216 Determination of Residue by Distillation of Emulsified Asphalts
LS-601 Materials Finer than 75 μm Sieve in Mineral Aggregates by Washing
LS-602 Sieve Analysis of Aggregates
LS-609 Petrographic Analysis of Coarse Aggregate
LS-625 Guidelines for Sampling of Granular Materials

Ontario Traffic Manual (OTM):
Book 7 - Temporary Conditions

SP-024 Manual for Condition Rating of Flexible Pavements

MTO Forms:

PH-CC-449a	Aggregate Test Data - Hot Mix Asphalt - Physical Properties, Fine Aggregate
PH-CC-449b	Aggregate Test Data - Hot Mix Asphalt - Physical Properties, Coarse Aggregate
PH-CC-449c	Aggregate Test Data - Hot Mix Asphalt - Superpave Consensus Properties

ASTM International

D 36-95 (2000)e1	Softening Point of Bitumen - Ring and Ball Apparatus

International Slurry Surfacing Association (ISSA)

TB-100-90	Test Method for Wet Track Abrasion of Slurry Surfaces
TB-109-90	Test Method for Measurement of Excess Asphalt in Bituminous Mixtures by Use of a Loaded Wheel Tester and Sand Adhesion
TB-113-90	Trial Mix Procedure for Slurry Seal Design
TB-114-90	Wet Stripping Test for Cured Slurry Seal Mix
TB-139-90	Test Method to Classify Emulsified Asphalt/Aggregate Mixture Systems by Modified Cohesion Tester Measurement of Set and Cure Characteristics
TB-144-90	Test Method for Classification of Aggregate Filler - Bitumen Compatibility by Schulze-Breuer and Ruck Procedures
TB-147-90	Test Methods for Measurement of Stability and Resistance to Compaction, Vertical and Lateral Displacement of Multi-layered Fine Aggregate Cold Mixes - Method A

336.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Appurtenances mean maintenance holes, catch basins, valve chambers, and water valve covers and similar Utility access covers located within the paved portion of the roadway.

Micro-Surfacing means a pavement surfacing composed of polymer-modified asphalt emulsion, high quality aggregate, mineral filler, and water.

Rut Filling means a layer of micro-surfacing placed on the existing pavement using a rut box on the longitudinal wheel path rut.

Scratch Coat means a layer of micro-surfacing placed on the existing pavement prior to placing a surface coat.

Siliceous Aggregates means rock particles containing or composed of silica (SiO_2) or minerals with silica in the crystal structure as silicate (SiO_4).

Surface Coat means a layer of micro-surfacing laid on a scratch coat or directly on the existing pavement.

336.04 DESIGN AND SUBMISSION REQUIREMENTS

336.04.01 Design Requirements

336.04.01.01 Mix Design

A laboratory equipped and staffed to carry out micro-surfacing mix designs shall designate the mix proportions and prepare the job mix formula.

The compatibility of the aggregate and the polymer modified emulsified asphalt shall be confirmed by the laboratory designing the mix.

All component materials used in the mix design shall be representative of the material to be used on the Contract.

Micro-surfacing material shall only be placed after the Contract Administrator has issued confirmation in writing within 5 Business Days that the mix design has been reviewed and meets the specified requirements.

The mix design proportions shall be within the following limits.

Residual Asphalt:

6.0 to 11.5% by dry mass of aggregate

Mineral Filler:

0 to 3.0% by dry mass of aggregate

The micro-surfacing material shall be designed to carry traffic within one hour of placement.

336.04.02 Submission Requirements

336.04.02.01 Mix Design

Two weeks prior to the start of micro-surfacing, the mix design shall be submitted in writing to the Contract Administrator together with the results of the tests listed in Table 1.

336.04.02.02 Submission of Test Data

The Contractor shall provide Quality Control (QC) test results of all aggregates and filler used in the Work from a laboratory meeting the requirements of the Laboratory Requirements clause. Test results showing complete conformance with the physical property requirements of this specification shall be provided to the Contract Administrator at the time of submission of the mix design.

QC test results shall be submitted using MTO forms PH-CC-449a, PH-CC-449b, or PH-CC-449c as applicable. Test data forms must be legible and signed by the testing laboratory representative. Electronic copies are acceptable providing the original is submitted to the Contract Administrator within 5 Business Days following receipt of the copy.

Only aggregate sample test data obtained from stockpiled material to be used in the Work and tested within the past 14 months shall be submitted.

336.04.02.03 Laboratory Requirements

An acceptable laboratory conducting tests for physical properties or consensus properties shall be one that holds a certificate from the Canadian Council of Independent Laboratories (CCIL) as Type D for the applicable test methods and also participates in the annual MTO Proficiency Sample Testing Program.

An acceptable laboratory conducting tests for LS-601 and LS-602 shall be one that holds a valid certificate from CCIL as Type C. Testing for LS-601 and LS-602 shall be conducted by qualified laboratory staff who hold a valid certificate from CCIL in aggregate testing. Testing for LS-609 shall be conducted by a person holding a valid certificate from CCIL showing them qualified in petrographic examination.

Equivalent alternate laboratory and technician certifications or laboratory proficiency sample testing programs may be used to demonstrate similar requirements, provided they are acceptable to the Owner.

336.05 MATERIALS

336.05.01 Polymer Modified Emulsified Asphalt

The emulsified asphalt shall be CSS-1H emulsion according to OPSS 1103 with a quick set polymer modifier and meeting the requirements of Table 2.

The polymer modifier shall be a minimum of 3% polymer solids by mass of asphalt cement residue in the emulsion.

The emulsion shall be homogeneous after mixing. To facilitate sampling and testing, the emulsion shall be stable for 14 Days after delivery to the job site. The polymer material shall be milled or blended into the asphalt cement or blended into the emulsifier solution prior to the emulsification process. The addition of polymers or other additives after the manufacture of the polymer modified emulsified asphalt is not permitted.

336.05.02 Aggregates

Aggregates shall be according to OPSS 1001.

Aggregates shall meet the requirements of Table 3. Aggregates for micro-surfacing Type II shall meet the requirements for a high traffic volume application.

Aggregates shall meet the gradation requirements of Table 4.

336.05.03 Mineral Filler

Mineral filler shall be Portland cement, Type GU, GL, according to OPSS 1301.

336.05.04 Water

The water shall be free of harmful salts and contaminants.

336.05.05 Mix Additives

Additives shall be compatible with the other components of the micro-surfacing mix.

336.05.06 Tack Coat

Tack coat shall be the same polymer modified emulsified asphalt used in the micro-surfacing mix and diluted to 1 part emulsion to 3 parts water by volume.

336.06 EQUIPMENT

336.06.01 Rotary Power Brooms

Rotary power brooms shall be capable of cleaning gravel, sand, dirt, and other debris from the roadway surfaces.

336.06.02 Mixing Equipment

The mixing equipment shall be specifically designed and manufactured to mix and place micro-surfacing material. Materials shall be mixed by an automatic sequenced, self-propelled, continuous flow micro-surfacing mixing machine. The mixing unit shall be capable of accurately delivering and proportioning the aggregate, emulsified asphalt, mineral filler, additives, and water to a revolving multi-blade double shaft mixer and discharging the mixed product in a continuous flow. The mixing equipment shall have sufficient storage capacity for aggregate, emulsified asphalt, mineral filler, additives, and water to maintain an adequate supply to meet mix design proportions.

336.06.03 Proportioning Devices

Individual volume or weight controls for proportioning aggregate, mineral filler, emulsified asphalt, additives, and water to be added to the mix shall be provided and properly marked.

336.06.04 Spreading Equipment

The mix shall be spread uniformly by means of a conventional augured surfacing spreader box attached to the mixing machine and equipped with paddles to agitate and spread the mix evenly throughout the box. A front seal shall be provided to ensure no loss of the mix at the pavement contact point. The rear seal shall act as final strike-off and shall be adjustable. The spreader box and rear strike off shall be designed to ensure that a uniform consistency is achieved to produce a free flow of material to the rear strike-off. The spreader box shall be equipped with a suitable means to adjust the box to compensate for variations in the pavement geometry. Rut filling spreader boxes shall be specifically designed for rut filling applications.

The spreading equipment shall be capable of being re-supplied with the micro-surfacing materials within the working lane to continuously place micro-surfacing for a minimum 2-lane-km distance. The machine shall be equipped to allow the operator to have full control of the forward and reverse speeds during application of the micro-surfacing.

336.06.05 Pilot Vehicle

The pilot vehicle shall be according to the requirements of the OTM, Book 7.

336.07 CONSTRUCTION

336.07.01 Operational Constraints

Micro-surfacing shall be placed only when the atmospheric temperature is at least 10 °C and rising and the weather is free of fog or rain and there is no forecast of temperatures below 0 °C within 24 hours from the time of application. The mix proportions shall be adjusted when weather conditions prolong opening to traffic beyond one hour.

Micro-surfacing shall commence no earlier than May 15 and shall be completed no later than September 30.

Traffic, including construction traffic, shall be kept off the freshly placed mixture to prevent damage to the surface and vehicles.

The Contractor shall delineate the centreline with short term pavement markings at the end of each Day of micro-surfacing placement. Short term pavement markings shall be according to OPSS 710.

336.07.02 Trial Area

A trial area 100 m in length and one lane wide shall be placed at the commencement of the micro-surfacing operation to demonstrate the ability to produce micro-surfacing in conformance with this specification. Within 1 hour of placement, the Contract Administrator shall inspect the micro-surfacing for conformance. The trial areas shall be repeated until the micro-surfacing meets the requirements of this specification. The location of the trial area shall be approved by the Contract Administrator.

336.07.03 Surface Preparation

The area to be surfaced shall be thoroughly cleaned using a rotary power broom to remove all sand, dirt, and other debris. Areas inaccessible to a rotary power broom shall be manually cleaned.

Existing crack sealing material shall be removed.

Existing durable pavement markings shall be removed.

Existing pavement surfaces to receive micro-surfacing shall be tack coated. Surfaces to be tack coated shall be free of standing water and contamination, such as mud, loose aggregate, and debris. Tack coat shall be applied at a rate of 0.25 to 0.40 kg/m^2 as determined by the Contractor based on the condition of the existing pavement surface. Tack coating shall be allowed to cure sufficiently before application of micro-surfacing.

Tack coat shall not be applied to existing pavement surfaces specified in the Contract Documents. Where tack coating is not required, water shall be applied to the pavement surface immediately ahead of the spreader to dampen the pavement surface without allowing any free-standing or free-flowing water.

All roadway appurtenances within the area of micro-surfacing shall be properly covered and protected immediately prior to placement of the micro-surfacing.

336.07.04 Mix Application

Micro-surfacing shall be placed as a scratch and surface coat or a surface coat only, as specified in the Contract Documents.

Additives may be added to the micro-surfacing mix during construction to provide control of the quick-set properties and to increase adhesion.

A sufficient amount of the mixture shall be carried in all parts of the spreader box at all times so that complete coverage is obtained. Water used to spray the spreader box to facilitate spreading shall not harm the mix. Lumping, balling, or unmixed aggregate shall not be permitted in the finished surface. Any oversized aggregate or foreign materials shall be screened from the aggregate prior to delivery to the mixing equipment.

The application rates for individual coats of micro-surfacing shall meet the requirements of Table 5.

Wheel track ruts of 13 mm or greater in depth shall be filled independently with micro-surfacing using a rut-filling spreader box prior to the application of other micro-surfacing. Ruts greater than 25 mm shall be filled with micro-surfacing applied with two passes of the rut filling spreader box. All rut-filling material shall cure under traffic for at least a 24-hour period before additional material is applied. The minimum width of a rut filling micro-surfacing application shall be 1.5 metres.

When specified, micro-surfacing shall be applied as a scratch coat to fill ruts less than 13 mm in depth, cracks and shallow potholes to leave a uniform surface.

336.07.04.01 Handwork

In restricted areas where hand spreading is necessary, adjustments to the mix formula may be made to retard the setting time. The mixture shall be placed along one edge of the surface to be covered and spread uniformly with squeegees or other suitable Hand Tools.

336.07.04.02 Appearance

Following placement, the micro-surfacing shall have a uniform texture free from excessive scratch marks, tears, indentations, or other surface irregularities. Tear marks or other surface irregularities in any 12 m^2 area per lane are considered excessive if there are:

a) four or more marks ≥ 12 mm wide and ≥ 100 mm long.

b) any marks ≥ 25 mm wide and ≥ 25 mm long.

There shall be no transverse ripples or longitudinal streaks of 6 mm or greater in depth when measured by placing a 3 m straight edge over the finished surface in any direction.

The edges of the micro-surfacing shall be finished uniformly, with a neat appearance along the roadway centreline, lane lines, shoulder, pavement edge, and curb lines.

336.07.04.03 Documentation

A summary of the quantity and application rate of micro-surfacing placed and a list of the quantities used for each of the mix components (i.e., aggregate, emulsified asphalt, water, mineral filler, and additive) shall be submitted daily to the Contract Administrator.

A summary of the station-to-station limits, quantity, and application rate of the tack coat shall be submitted daily to the Contract Administrator.

336.07.04.04 Joints

The longitudinal and transverse joints shall be neat and uniform in appearance, with no excessive build-up. Longitudinal joints shall be placed on lane lines.

The longitudinal joints in the scratch coat shall be constructed as a butt joint.

The longitudinal joint in the surface course shall have an overlap of 50 to 100 mm.

336.07.05 Clean Up

All areas not to be micro-surfaced, such as shoulders, ditches, and gutters, shall have the micro-surfacing material removed on a daily basis.

Appurtenances shall be free of micro-surfacing and left in operable condition.

336.07.06 Traffic Convoy

The Contractor shall convoy traffic according to the OTM, Book 7.

The pilot vehicle shall guide one-way traffic through or around construction. The maximum speed of the convoy shall be 30 km/h. Convoying shall be maintained until such time as the micro-surfacing mixture is able to carry traffic without damage.

336.07.07 Repairs

All repairs to address appearance deficiencies described in the Appearance clause shall consist of an additional application of micro-surfacing for the full lane width over the length of deficiency.

The length of repair shall be sufficient to eliminate all appearance deficiencies. If the distance between repair areas is less than 3 m, then the adjacent repairs shall be treated as one repair.

336.07.08 Management of Excess Material

Management of excess material shall be as specified in the Contract Documents.

336.08 QUALITY ASSURANCE

336.08.01 Sampling and Testing

Sampling shall be conducted by the Contractor according to LS-625. Quality assurance (QA) samples shall be taken from stockpiles of aggregate to be used in the Work. Sampling locations shall be determined by the Contract Administrator.

Duplicate samples shall be obtained and sealed by the Contractor in the presence of the Contract Administrator. One of the duplicate samples shall be randomly selected for testing by the QA laboratory and the remaining sealed sample shall be retained by the QA laboratory for possible referee testing. In the event that the Contractor is unavailable to take the sample, no further material shall be placed in the Work until the QA sample has been taken. Samples shall be of sufficient mass of the material to conduct the necessary gradation and physical property tests.

All QA samples shall be delivered by the Contractor, within 24 hours of sampling, to a location specified in the Contract Documents.

Notwithstanding the requirements for QA sampling as indicated in this specification, the Owner reserves the right to obtain a QA sample at any time without notice.

336.08.02 Warranty Requirements

336.08.02.01 Warranty Period

The Warranty Period shall be 24 months.

336.08.02.02 Completion of Warranty Period

At the end of the Warranty Period, the work shall meet the provisions of the Performance Requirements clause in order for the Contractor to be released from responsibility and ensure return of the performance bond or letter of credit or certified cheque.

336.08.02.03 Distress Survey

The Owner shall complete a distress survey in accordance with the severity and density definitions provided in SP-024 after the end of 1 year and a second distress survey a minimum of 45 Days prior to the end of the Warranty Period. The results of both surveys shall be sent to the Contractor.

If the Owner determines that the distresses pose a hazard to the travelling public at any time during the Warranty Period, the Contractor shall be required to make the repairs in accordance with this specification within 2 weeks of being notified. Repairs shall be made to the approval of the Owner.

336.08.02.04 Performance Requirements

At the end of the Warranty Period, the micro-surfacing shall be free from any aggregate loss or ravelling that is slight to very severe and from flushing that is moderate to very severe. The density of flushing that is very slight to slight shall not be greater than intermittent.

If the micro-surfacing does not meet these performance requirements, the necessary repair or replacement methods shall be according to Table 6. Repairs shall be made to the approval of the Owner.

The length of repair shall be sufficient to eliminate all surficial defects as described. If the distance between repair areas is less than 3 m, then the adjacent repairs shall be treated as one repair.

336.09 MEASUREMENT FOR PAYMENT

336.09.01 Actual Measurement

336.09.01.01 Micro-Surfacing Type II
Micro-Surfacing Type III Modified
Micro-Surfacing Type III

Measurement of the micro-surfacing placed shall be by area in square metres.

336.10 BASIS OF PAYMENT

336.10.01 Micro-Surfacing Type II - Item
Micro-Surfacing Type III Modified - Item
Micro-Surfacing Type III - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

All costs associated with repairing and replacing unacceptable trial areas shall be borne by the Contractor.

The accepted trial area shall be paid for at the Contract unit price for micro-surfacing.

Repair, removal, disposal, and replacement of any damaged or defective micro-surfacing shall be at no extra cost to the Owner.

Any work requirements, as determined by the distress survey for repair or replacement of micro-surfacing, shall be completed at no extra cost to the Owner.

All costs for handling and delivery of samples shall be the responsibility of the Contractor.

TABLE 1
Mix Design Requirements

Test Method	Description	Requirements
ISSA TB-139	Wet cohesion - @ 30 minutes min. (Set) - @ 60 minutes min. (Traffic)	 12 kg-cm minimum 20 kg-cm minimum
ISSA TB-109	Excess asphalt by LWT sand adhesion	538 g/m^2 maximum
ISSA TB-114	Wet stripping	90% minimum
ISSA TB-100	Wet track abrasion loss-one hour soak Loss-six day soak	538 g/m^2 maximum 807 g/m^2 maximum
ISSA TB-147 Method A	Lateral displacement Specific gravity after 1000 cycles of 57 kg	5% maximum 2.10 maximum
ISSA TB-144	Classification compatibility	(AAA, BAA) 11 Grade Points minimum
ISSA TB-113	Mix time @ 25 °C	Controllable to 120 seconds minimum

TABLE 2
Tests on Residue

Test Method	Description	Requirements
LS-216	Residue by distillation	62% by mass minimum
ASTM D 36	Softening point	57 °C minimum
LS-200	Penetration at (25 °C, 100 g, 5 s)	40 - 90
LS-202	Kinematic Viscosity @ 135 °C	650 mm^2/s minimum

TABLE 3
Micro-Surfacing Coarse and Fine Aggregates Requirements

Micro-Surfacing Type	Application	Physical Requirements as Specified in OPSS 1003
II	Low Traffic Volume	Superpave 12.5
II	High Traffic Volume	Superpave 12.5 FC1
III Modified	N/A	Superpave 12.5 FC1
III	N/A	Superpave 12.5 FC1

Note:

A. Aggregates meeting the physical requirements of Superpave 12.5 aggregates shall be produced from quarried bedrock consisting of 100 % siliceous aggregate determined in accordance with LS-609.

TABLE 4
Gradation Requirements

Percent Passing, LS-602			
MTO Sieve Designation	**Micro-Surfacing Type II**	**Micro-Surfacing Type III Modified**	**Micro-Surfacing Type III**
9.5 mm	100	100	100
6.7 mm	--	95-100	--
4.75 mm	90-100	80-95	70-90
2.36 mm	65-90	50-75	45-70
1.18 mm	45-70	33-55	28-50
600 μm	30-50	25-40	19-34
300 μm	18-30	15-30	12-25
150 μm	10-21	7-20	7-18
75 μm	5-15	5-15	5-15

TABLE 5
Micro-Surfacing Single Layer Application Rates

Micro-Surfacing Type	Application Rate kg/m^2
Type II	5 to 11
Type III and Type III Mod	8 to 16

TABLE 6
Micro-Surfacing Repair and Replacement Methods

Surface Defects	Severity	Density	Repair/Replacement Method
Flushing	Very slight to slight	Frequent to throughout	Resurface with one layer of micro-surfacing for a full lane width
	Moderate to very severe	Few to throughout	Removal by milling of all flushed areas for a full lane width and replace with two layers of micro-surfacing.
Aggregate Loss / Ravelling	Slight to moderate	Few to throughout	Resurface with one lift of micro-surfacing for a full lane width.
	Severe to very severe	Few to throughout	Fill in delaminations/potholes with micro-surfacing and resurface with two layers of micro-surfacing.

Note:

A. Surface defect definitions according to SP-024.

Appendix 336-A, November 2018
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

Micro-surfacing is a thin wearing course that seals the pavement surface and improves frictional resistance. Micro-surfacing does not address structural deficiencies.

The designer should specify the following in the Contract Documents:

- Any existing pavement surfaces not requiring tack coat. (336.07.03)

- If the application is to be one or two coats (i.e., scratch and surface or only surface). (336.07.04)

- Location of testing laboratory for sample delivery. (336.08.01)

- Type of micro-surfacing. (336.10.01)

If verbal confirmation of the mix design review and compliance is acceptable or no mix design review is required, the designer should consider deleting the requirement for the Contract Administrator to issue confirmation in writing that the mix design has been reviewed and meets the specified requirements. (336.04.01.01)

For projects with extensive intersection and urban work, the designer should consider deleting the requirement for equipment capable of continuous placement operations and allowing for a truck mounted unit. (336.06.04)

Crack sealant is typically removed prior to micro-surfacing when the crack sealant shows signs of deterioration or debonding. Crack sealant that has been in place less than 1 year can interfere with the micro-surfacing operations. For projects with existing crack sealant, the designer should determine if the crack sealant should be left in place and if so, delete the requirement for the removal of the existing crack sealing material. (336.07.03)

If a thick scratch coat is anticipated, the designer may consider deleting the requirement for tack coat. (336.07.03)

For projects with ruts greater than 13 mm, the designer should consider specifying the locations for the use of a rut-filling spreader box, including the locations for 2 passes of the rut filling spreader box. (336.07.04) When the average rut depth is greater than 20 mm, the designer should consider requiring a coarse aggregate gradation (Type III gradation) for rut fill mix.

For projects where a traffic convoy is not feasible or desired, the designer should consider deleting the requirement for a traffic convoy. (336.07.06)

If the forms in Appendices 336-B, 336-C, or 336-D are to be used for submission purposes rather than the MTO forms, they need to be invoked by reference in the Contract Documents and a special provision should be written to delete the MTO forms from the specification.

Typically two coats (i.e., scratch and surface coats) are specified to remove severe surface defects.

This specification should not be used in areas with the prevalence of studded tires or where pavements exhibit high deflection.

Appendix 336-A

Type II micro-surfacing with Superpave 12.5 quality aggregate is used on local residential streets and low volume arterial and collectors. Type II micro-surfacing with Superpave 12.5 FC1 quality aggregate is used on higher volume arterials and collectors. Type III micro-surfacing is used on freeways and other high speed, high volume roads. Type III Modified micro-surfacing is used in lieu of Type III micro-surfacing to reduce traffic generated noise.

Micro-surfacing should be carried out in warm dry weather.

Micro-surfacing should be carried out between May 15 and September 30.

Routing and crack sealing should not be carried out prior to micro-surfacing.

Quality of micro-surfacing is critically dependent on appropriate mix design, equipment, and construction experience.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

Appendix 336-B, November 2018
FOR USE IN MUNICIPAL CONTRACTS, WHEN REFERENCED IN THE CONTRACT DOCUMENTS

Note: This is a non-mandatory Additional Information Appendix intended to provide supplementary requirements for the OPS specification in a municipal contract, when the appendix is invoked by the Owner. It is written in mandatory language to permit invoking it by reference in the Contract Documents. If the appendix has not been invoked by reference in the Contract Documents, it does not apply.

Hot Mix Asphalt Fine Aggregate Test Data - Physical Properties

Municipality:		**Consultant:**	
Contract Name:			
Contract No.:	**Contractor:**	**Contract Location:**	
Testing Laboratory:		**Telephone No.:**	**Fax No.:**
Sampled by:		**Date Sampled:**	**___QC**
Mix Type:	**Lot No.:**	**Quantity (tonnes):**	**QA:** **___Stockpile** **___Cold Feed**
Source Name:			**Aggregate Inventory No.:**

Laboratory Test and Number	**Requirement**			**Test Result**		
	SMA, DFC, OFC, & Superpave 12.5FC2	HL1, HL3, & Superpave 12.5FC1	HL2, HL4, HL8, HDBC, MDBC, & Superpave 9.5, 12.5, 19.0, 25.0, 37.5	Reference Material	Sample	Meets Requirement (Y/N)
Micro-Deval Abrasion loss, % maximum, LS-619 (Note 1)	15	20	25			
Plasticity Index, maximum, LS-704	0	0	0			

Note:

1. For blended aggregates sampled from the cold feed, the Micro-Deval Abrasion loss of each individual fine aggregate in stockpile, prior to blending, shall not exceed 35 percent.

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Appendix 336-C, November 2018
FOR USE IN MUNICIPAL CONTRACTS, WHEN REFERENCED IN THE CONTRACT DOCUMENTS

Note: This is a non-mandatory Additional Information Appendix intended to provide supplementary requirements for the OPS specification in a municipal contract, when the appendix is invoked by the Owner. It is written in mandatory language to permit invoking it by reference in the Contract Documents. If the appendix has not been invoked by reference in the Contract Documents, it does not apply.

Hot Mix Asphalt Coarse Aggregate Test Data - Physical Properties

Municipality:		Consultant:	
Contract Name:			
Contract No.:	Contractor:	Contract Location:	
Testing Laboratory:		Telephone No.:	Fax No.:
Sampled by:		Date Sampled:	___QC QA: ___Stockpile ___Cold Feed
Mix Type:	Lot No.:	Quantity (tonnes):	
Source Name:			Aggregate Inventory No.:

Requirement: HL1, SMA, DFC, OFC, and Superpave 12.5FC1, 12.5FC2						**Test Result**		
Laboratory Test and Number	**Gravel**	**Quarry Rock**				Reference Material	Sample	Meets Requirements (Y/N)
	HL1 & 12.5FC1 only	Dolomitic Sandstone (**D**)	Traprock, Diabase & Andesite (**T**)	Meta-Arkose & Gneiss (**M**)	Rock Type (Note 1)			
Wash Pass 75 μm Sieve, % maximum, LS-601 (Note 2)	1.0	1.0	1.0	1.0				
Absorption by mass, % maximum, LS-604	1.0	1.0	1.0	1.0				
Flat and Elongated Particles (4:1), % maximum, LS-608	15	15	15	15				
Petrographic Number (HL), maximum, LS-609	120	145	120	145				
Insoluble Residue, retained 75 μm Sieve, % minimum, LS-613	-	45	-	-				
Unconfined Freeze Thaw Loss, % maximum, LS-614	6	7	6	6				
2 Faces Crushed Particles, % minimum, LS-617 (HL1 only)	80	-	-	-				
Micro-Deval Abrasion Loss, % maximum, LS-618	5	15	10	15				

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Requirement: HL3, HL3HS, HL4, HL8, HDBC, MDBC, and Superpave 9.5, 12.5, 19.0, 25.0, 37.5						**Test Result**		
Laboratory Test and Number	HL3 & HL3HS	HL4 Surface & 12.5 (Note 3)	HL4 Binder, HL8, & 9.5, 19.0, 25.0, 37.5	HDBC	MDBC	Reference Material	Sample	Meets Requirements (Y/N)
Wash Pass 75 μm Sieve, % maximum, LS-601 (Note 4)	1.3/2.0	1.3/2.0	1.3/2.0	1.3/2.0	1.3/2.0			
Absorption by mass, % maximum, LS-604	1.75	2.0	2.0	2.0	2.0			
Percent Crushed Particles, % minimum, LS-607 (Note 5)	60 / 80	60 / 80	60 / 80	-	-			
Flat and Elongated Particles (4:1), % maximum, LS-608 (Note 6)	20	20	20	15	15			
Petrographic Examination, % non-carbonate ret 4.75 mm, LS-609	(Note 7)		-	-	-			
Unconfined Freeze-Thaw loss, % maximum, LS-614	6	6	15	15	15			
2 Faces Crushed Particles, % minimum, LS-617 (Note 8)	-	-	-	95	80			
Micro-Deval Abrasion loss, % maximum, LS-618	17	17	21	21	21			
$MgSo_4$ Soundness loss, % maximum, LS-606 (Note 9)	12	12	15	15	15			

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Notes:

1. Enter the type of rock or material used in the mix as follows:

   D - dolomitic sandstone
   T - traprock, diabase, andesite
   M - meta-arkose, gneiss

2. HL1, SMA, DFC, OFC and Superpave 12.5FC1, 12.5FC2 only: When control charts (n>20) are used for LS-601, the average value shall not exceed the specification maximum (1.0%) with no single value greater that 1.4%.

3. These physical requirements for HL4 apply where the asphaltic concrete forms the surface upon which vehicular traffic will directly travel, otherwise, the physical requirements for HL4 Binder apply.

4. HL3, HL4, HL8, HDBC, MDBC and Superpave 9.5, 12.5, 19.0, 25.0, 37.5 only: When control charts (n>20) are used for LS-601, the average value shall not exceed 1.3% with no single value greater than 1.7%. When quarried rock is used, a maximum of 2.0% passing the 75 μm sieve is permitted. When control charts (n>20) are used for LS-601 for quarried rock, the average value shall not exceed 2.0%, with no single value greater than 2.4%.

5. HL3, HL4, HL8, HDBC, MDBC only: For hot mix aggregates used on 400 series highways and Highways 3, 6, 7, 10, 11, 12, 17, 26, 28, 35, 61, 69, 102, and 115, the minimum percent crushed particles is 80%.

6. For Superpave 9.5, 19.0, 25.0, and 37.5 only: Where HDBC and MDBC mixes have historically been used, this requirement is reduced to 15%. Check Contract Documents for this requirement.

Appendix 336-C

7. This requirement is applicable to surface course aggregates in the area to the north and west of a boundary defined as follows: the north shore of Lake Superior, the north shore of the St. Mary's River, the south shore of St. Joseph Island, the north shore of Lake Huron easterly to the north and east shore of Georgian Bay (excluding Manitoulin Island), along the Severn River to Washago and a line easterly passing through Norland, Burnt River, Burleigh Falls, Madoc, and hence easterly along Highway 7 to Perth and northerly to Calabogie and easterly to Arnprior and the Ottawa River.

    a. When the coarse aggregate for surface course mix is obtained from a gravel pit or quarry containing more than 40% limestone and dolostone in the retained 4.75 mm portion of the coarse aggregate, then blending with aggregate of non-carbonate rock type shall be required. The blend shall be such as to increase the non-carbonate rock type content of the coarse aggregate to 60^ minimum of the retained 4.75 mm portion, as determined by petrographic examination (LS-609). The method of blending shall be such as to produce uniform blending and shall be subject to approval by the Owner. In cases of dispute, the acid insoluble residue test shall be used (LS-613) with a minimum acid insoluble residue of 60%.

    b. When the coarse aggregate for surface course mix is obtained from a non-carbonate source, blending with carbonate rocks (Limestone and dolostone) shall not be permitted.

8. This only applies to HDBC and MDBC coarse aggregate crushed from gravel sources. Maximum allowable amount of uncrushed particles is 5% (MDBC only).

9. Compliance with this requirement is waived if the aggregate meets the alternative unconfined freeze-thaw requirement (LS-614).

Appendix 336-D, November 2018
FOR USE IN MUNICIPAL CONTRACTS, WHEN REFERENCED IN THE CONTRACT DOCUMENTS

Note: This is a non-mandatory Additional Information Appendix intended to provide supplementary requirements for the OPS specification in a municipal contract, when the appendix is invoked by the Owner. It is written in mandatory language to permit invoking it by reference in the Contract Documents. If the appendix has not been invoked by reference in the Contract Documents, it does not apply.

Hot Mix Asphalt Superpave Aggregate Test Data - Consensus Properties

Municipality:		Consultant:	
Contract Name:			
Contract No.:	Contractor:	Contract Location:	
Testing Laboratory:		Telephone No.:	Fax No.:
Sampled by:		Date Sampled:	___QC QA: ___Stockpile ___Cold Feed
Mix Type:	Lot No.:	Quantity (tonnes):	
Source Name:			Aggregate Inventory No.:

FINE AGGREGATE								
Source Name/Location:						Aggregate Inventory Number (AIN):		
Laboratory Test and Number		**Requirement**					**Test Result**	
		Traffic Level Category					Sample	Meets Requirements (Y/N)
		A	B	C	D	E		
Uncompacted Voids, % minimum, AASHTO T304	≤100 mm (Note 1)	-	40	45	45	45		
	>100 mm (Note 1)	-	40	40	40	100/100		
Sand Equivalent, % minimum, AASHTO T176 (Notes 2, 3)		-	40	40	40	45		

COARSE AGGREGATE								
Source Name/Location:						Aggregate Inventory Number (AIN):		
Laboratory Test and Number		**Requirement**					**Test Result**	
		Traffic Level Category					Sample	Meets Requirements (Y/N)
		A	B	C	D	E		
Fractured Particles, % minimum, ASTM D 5821 (Note 3)	≤100 mm (Note 1)	55/-	75/-	85/80	95/90	100/100		
	>100 mm (Note 1)	-	50/-	60/-	80/75	100/100		
Flat and Elongated particles (5:1), % minimum, ASTM D 4791		-	10					

Appendix 336-D

Notes:

1. Denotes the depth of the top of lift below final pavement surface. If less that 25% of a layer is within 100 mm of the surface, the layer may be considered to be below 100 mm.

2. This requirement is waived for total fine aggregate containing RAP.

3. A minimum uncompacted void content of 43% is acceptable provided that the selected mix satisfies the mix volumetrics specified elsewhere in the Contract Documents.

4. 85/80 denotes that 85% of the coarse aggregate has one fractured face and 80% has two or more fractured faces.

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CONSTRUCTION SPECIFICATION FOR SLURRY SEAL

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APPENDICES

337-A **Commentary**

337.01 SCOPE

This specification covers the requirements for slurry seal and includes all surface preparation, material application, handwork, joints, protection while curing, clean up, and provision for a trial area.

337.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

337.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

337.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Material

OPSS 1001	Aggregates - General
OPSS 1003	Aggregates - Hot Mix Asphalt
OPSS 1103	Emulsified Asphalt
OPSS 1301	Cementing Materials
OPSS 1302	Water

Ontario Ministry of Transportation Publications

MTO Laboratory Testing Manual:
LS 602 - Sieve Analysis of Aggregates

Ontario Traffic Manual (OTM):
Book 7 - Temporary Conditions

ASTM International

D 3910-15 Standard Practices for Design, Testing and Construction of Slurry Seal

International Slurry Surfacing Association (ISSA)

TB 106-90 Measurement of Slurry Seal Consistency
TB 109-2005 Test Method for Measurement of Excess Asphalt in Bituminous Mixtures by Use of a Loaded Wheel Tester and Sand Adhesion
TB 114-90 Wet Stripping Test for Cured Slurry Seal Mix
TB 115-90 Determination of Slurry System Compatibility
TB 139-90 Test Method to Classify Emulsified Asphalt/Aggregate Mixture Systems by Modified Cohesion Tester Measurement of Set and Cure Characteristics

337.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Appurtenances mean maintenance holes, catch basins, valve chambers, and water valve covers and similar Utility access covers located within the paved portion of the roadway.

Slurry Seal means a homogeneous mixture of emulsified asphalt, fine aggregates, water, mineral filler, and, if required, additive. This mixture is applied in a cold fluid state on a prepared bituminous surface.

337.04 DESIGN AND SUBMISSION REQUIREMENTS

337.04.01 Design Requirements

A laboratory that is equipped and staffed to carry out slurry seal mix designs with, as a minimum, a current CCIL Type C Certification or an equivalent laboratory shall designate the mix proportions and prepare the job mix formula.

The compatibility of the aggregate and the emulsified asphalt shall be confirmed by the laboratory designing the mix.

All component materials used in the mix design shall be representative of the material to be used on the Contract.

Slurry seal shall only be placed after the Contract Administrator has issued confirmation in writing that the mix design has been reviewed and meets the specified requirements.

The mix design proportions shall be within the following limits:

Residual Asphalt:

Slurry Seal - Type I	10 to 16% by dry mass of aggregate
Slurry Seal - Type II	7.5 to 13.5% by dry mass of aggregate
Slurry Seal - Type III	6.5 to 12% by dry mass of aggregate

Mineral Filler:

0.5 to 2.0% by dry mass of aggregate

The slurry seal material shall be designed to carry traffic within 4 hours of placement.

337.04.02 Submission Requirements

337.04.02.01 Mix Design

Two weeks prior to the start of the slurry seal operation, the mix design shall be submitted in writing to the Contract Administrator together with the results of the tests listed in Table 1.

337.05 MATERIALS

337.05.01 Emulsified Asphalt

The emulsified asphalt shall be specially designed for slurry seal work and shall meet the requirements of OPSS 1103.

337.05.02 Aggregates

The aggregates shall be according to Table 2 and OPSS 1001. The aggregate shall meet the physical requirements of Superpave 12.5 mix for the traffic category specified in the Contract Documents according to OPSS 1003, except that the maximum absorption for coarse aggregate shall not be more than 1.75%.

337.05.03 Mineral Filler

Mineral filler shall be Portland cement, Type GU, GL, according to OPSS 1301.

337.05.04 Water

The water shall be free of harmful salts and contaminants, according to OPSS 1302.

337.05.05 Mix Additives

Additives may be added to the slurry seal mix during construction to provide control of the quick-set properties and to increase adhesion. Additives shall be compatible with the other components of the slurry seal mix.

337.05.06 Tack Coat

Tack coat shall be the same emulsified asphalt used in the mix and diluted to 1 part emulsion to 3 parts water by volume.

337.06 EQUIPMENT

337.06.01 Rotary Power Brooms

Rotary power brooms shall be capable of cleaning gravel, sand, dirt and other debris from the roadway surfaces.

337.06.02 Mixing and Spreading Equipment

Mixing equipment shall be specifically designed and manufactured to mix slurry seal material.

Spreading equipment shall be designed to apply a fine mist of water on the road surface immediately prior to placement of slurry seal.

The spreading equipment shall also have a spreader box and rear strike-off and be designed and operated to ensure that a uniform consistency is achieved and to produce a free flow of material to the rear strike-off. The spreader box shall be equipped with a suitable means to adjust the box to compensate for variations in the pavement geometry. The spreader box shall be capable of spreading slurry in one pass at varying widths up to 3.75 m.

337.06.03 Proportioning Devices

Individual volume or weight controls for proportioning aggregate, mineral filler, emulsified asphalt, additives, and water to be added to the mix shall be provided and properly marked.

337.06.04 Pilot Vehicle

The pilot vehicle shall be according to the requirements of the OTM, Book 7.

337.07 CONSTRUCTION

337.07.01 Operational Constraints

Slurry seal shall be placed only when the atmospheric temperature is at least 10 °C and rising and the weather is free of fog or rain and there is no forecast of temperatures below 0 °C within 24 hours from the time of application.

Slurry seal shall commence no earlier than May 15 and shall be completed no later than September 30.

Traffic, including construction traffic, shall be kept off the freshly placed mixture to prevent damage to the surface.

337.07.02 Trial Area

A trial area 100 m in length and one lane wide shall be placed at the commencement of the slurry seal operation, to demonstrate the ability to produce slurry seal according to this specification. Within 4 hours of placement, the Contract Administrator shall inspect the slurry seal for conformance. The trial area shall be repeated until the slurry sealing meets the requirements of this specification. The location of the trial area shall be approved by the Contract Administrator.

337.07.03 Surface Preparation

The area to be surfaced shall be thoroughly cleaned using a rotary power broom. Areas inaccessible to the rotary power broom shall be cleaned manually.

Existing durable pavement markings shall be removed.

When specified in the Contract Documents, all existing pavement surfaces to receive slurry seal shall be tack coated. Surfaces to be tack coated shall be free of standing water and contamination, such as mud, loose aggregate, and debris. Tack coat shall be applied at a rate of 0.25 to 0.40 kg/m^2 as determined by the Contractor based on the condition of the existing pavement surface. Tack coating shall be allowed to cure sufficiently before application of slurry seal.

All roadway appurtenances within the area to receive slurry seal shall be properly covered and protected immediately prior to the placement of the slurry seal.

337.07.04 Mixture Application

Slurry seal shall be placed according to the application rates specified in Table 3.

337.07.05 Handwork

Areas which cannot be reached with the slurry seal spreading equipment shall be surfaced using hand squeegees to provide complete and uniform slurry seal coverage. The area to be hand worked shall be lightly dampened prior to slurry seal placement and the slurry seal applied concurrent with adjacent machine applied slurry seal.

337.07.06 Appearance

Following placement the slurry seal shall have a uniform texture, free from excessive scratch marks, tears, indentations, or other surface irregularities. Tear marks in any 12 m^2 area per lane are considered excessive if there are:

a) Four or more marks $\geq$ 12 mm wide and $\geq$ 100 mm long

b) Any marks $\geq$ 25 mm wide and $\geq$ 25 mm long

There shall be no longitudinal ripples, raking, wash-boarding, chatter, or other irregularities that affect the ride quality.

The edges of the slurry seal shall be finished uniformly, with a neat appearance along the roadway centreline, lane lines, shoulder, pavement edge, and curb lines.

337.07.07 Documentation

A summary of the quantity and application rate of slurry seal placed and a list of the quantities used for each of the slurry seal components (i.e., aggregate, emulsified asphalt, mineral filler, and additive) shall be submitted daily to the Contract Administrator.

337.07.08 Joints

The longitudinal and transverse joints shall be neat and uniform in appearance with no excessive build-up. Longitudinal joints shall be placed on lane lines.

The longitudinal joint in the surface course shall have an overlap of 50 to 100 mm.

337.07.09 Clean Up

All areas not to be slurry sealed, such as shoulders, ditches, and gutters, shall have the slurry seal material removed on a daily basis. Appurtenances shall be free of slurry seal and left in operable condition.

337.07.10 Repairs

Damaged slurry sealed surfaces shall be repaired.

Repairs to address appearance deficiencies described in the Appearance subsection shall consist of an additional application of slurry seal for the full lane width over the length of deficiency.

The length of repair shall be sufficient to eliminate all appearance deficiencies. If the distance between repair areas is less than 3 m, these repair areas shall be treated as one continuous repair.

337.07.11 Traffic Convoy

When specified in the Contract Documents, traffic shall be convoyed according to the OTM, Book 7.

The pilot vehicle shall guide one-way traffic through or around construction. The maximum speed of the convoy shall be 30 km/h. Convoying shall be maintained until such time as the slurry seal is able to carry traffic without damage.

337.07.12 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

337.08 QUALITY ASSURANCE

337.08.01 Sampling

The aggregate shall be stockpiled 2 weeks prior to construction for sampling and testing. Samples for gradation testing shall be taken from the stockpile as determined by the Contract Administrator.

337.09 MEASUREMENT FOR PAYMENT

337.09.01 Actual Measurement

337.09.01.01 Slurry Seal - Type I
Slurry Seal - Type II
Slurry Seal - Type III

Measurement of the slurry seal placed shall be by area in square metres with no deductions for appurtenances.

337.09.01.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

337.10 BASIS OF PAYMENT

337.10.01 Slurry Seal - Type I - Item
Slurry Seal - Type II - Item
Slurry Seal - Type III - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Repair, removal, disposal, and replacement of any damaged or defective slurry seal shall be at no extra cost to the Owner.

The accepted trial area shall be paid for at the tender unit price for slurry seal. All costs associated with unacceptable trial areas shall be borne by the Contractor at no extra cost to the Owner.

TABLE 1
Mix Design Requirements

Test Method	Description		Requirements	
			Minimum	Maximum
ISSA TB-106	Slurry Seal Consistency, cm		2	3
ISSA TB-109	Excess Asphalt, g/m^2		550	750
ISSA TB-114	Wet Stripping, % Retained Coating		90	100
ISSA TB-115	Compatibility		Pass Tests (Note 1)	
ASTM D 3910	Wet Track Abrasion, g/m^2		---	800
ISSA TB-139	Set and Cure Characteristics			
	Set Time	12 kg-cm minimum @ 30 minutes		
	Traffic Time	20 kg-cm minimum @ 240 minutes		

Note:

1. Mixing tests must pass at the maximum expected air temperature.

TABLE 2
Slurry Seal Aggregate Gradation Requirements, LS-602

MTO Sieve Designation	Type I Percent Passing	Type II Percent Passing	Type III Percent Passing
9.5 mm	100	100	100
4.75 mm	100	90 - 100	70 - 100
2.36 mm	90 - 100	65 - 90	45 - 70
1.18 mm	65 - 90	45 - 70	28 - 50
600 μm	40 - 65	30 - 50	19 - 34
300 μm	25 - 42	18 - 30	12 - 25
150 μm	15 - 30	10 - 21	7 - 18
75 μm	10 - 20	5 - 15	5 - 15

TABLE 3
Slurry Seal Application Rates

Slurry Seal Type	Application Rate kg/m^2
Type I	4.3 to 6.5
Type II	5.4 to 9.8
Type III	8.1 to 12.0

Appendix 337-A, November 2018
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Traffic category. (337.05.02)

The designer should determine if the following is required and, if so, specify it in the Contract Documents:

- Tack coat. (337.07.03)

- Traffic convoy. (337.07.11)

Slurry seal is specified to seal the surface, prevent ravelling, and improve frictional characteristics. It is not intended to increase the structural strength of pavement. Pavements that are structurally deficient or exhibiting severe distress should be sealed and distortions repaired prior to slurry seal application. A detailed pavement condition investigation should be carried out to determine the appropriateness of specifying slurry seal.

The three generally accepted types of slurry seal are:

Type I - is a fine gradation mix for sealing low volume residential road surfaces.

Type II - is a medium gradation mix used for sealing road surfaces on moderate volume residential road surfaces.

Type III - is a coarse gradation mix used to improve skid resistance on moderate volume municipal road surfaces.

Selection of slurry seal type is dependent on traffic volumes and surface friction requirements.

Where slurry seal is considered for higher volume roadways, the use of a premium aggregate or micro-surfacing is recommended.

Normally, tack coat is not required unless the surface to be covered is extremely dry and ravelled or it is concrete or brick.

Traffic should be prohibited from the finished surface for a period of up to four hours to permit the slurry seal to cure. This may necessitate a separate pay item for traffic control.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

CONSTRUCTION SPECIFICATION FOR ROUTING AND SEALING CRACKS IN HOT MIX ASPHALT PAVEMENT

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341-A **Commentary**

341.01 SCOPE

This specification covers the work of routing existing cracks up to 20 mm in width and cleaning and sealing routed and unrouted cracks in hot mix asphalt pavements with hot poured rubberized asphalt sealant compound.

341.01.01 Specification Significance and Use

This specification has been developed for use in municipal-oriented Contracts. The administration, testing, and payment policies, procedures, and practices reflected in this specification correspond to those used by many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

341.01.02 Appendices Significance and Use

Appendices are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

341.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specification, Material

OPSS 1212 Hot Poured Rubberized Asphalt Joint Sealing Compound

Ministry of Transportation, Ontario, Publication

SP-024 Manual for Condition Rating of Flexible Pavements - Distress Manifestations

341.04 DESIGN AND SUBMISSION REQUIREMENTS

341.04.01 Submission Requirements

The Contract Administrator shall be provided with the following data at least five Business Days prior to placement of sealant:

a) The sealant information from the manufacturer shall include:

   i. Batch numbers.

   ii. Test results shall be according to OPSS 1212 from each batch on samples that have been subjected to both one heating cycle and two heating cycles.

   iii. Application recommendations.

iv. Recommended heating time and temperature.

v. Allowable storage time and temperature after initial heating.

vi. Allowable reheating criteria.

vii. Application temperature range.

b) Storage location of sealant pucks.

341.05 MATERIALS

341.05.01 Crack Sealant

Crack sealant shall be hot poured rubberized asphalt sealant according to OPSS 1212.

341.06 EQUIPMENT

341.06.01 Router

All routing equipment shall consist of mechanical routers capable of continually creating well-defined right-angled routs and keeping the rout centreline within 8 mm of the centre of the crack and providing a rout width of 40 to 50 mm and a depth of not less than 8 mm. For surfaces that are to be overlaid with hot mix as part of the Contract, rout geometry of 20 x 20 mm shall be used. Such capability shall be demonstrated to the Contract Administrator prior to its use.

When it cannot be demonstrated to the satisfaction of the Contract Administrator that a router is capable of maintaining the specified dimensions and shape of the rout, then as many cutters in the router's cutting head shall be adjusted or replaced as necessary, until the dimensions and shape of the rout again meets the specification requirements.

341.06.02 Heating Kettle

The heating kettle for joint sealant compound shall be a double boiler oil heat transfer type with built in agitator and equipped with thermometers to measure the temperature of both heat transfer oil and the sealing compound. The heating kettle shall be equipped with a spigot.

The heating kettle shall have automatic thermo controls that will prevent overheating of the sealant.

341.06.03 Hot Compressed Air Lance

The hot compressed air lance shall have a discharge air temperature of approximately 500 °C ± 100 °C and an air velocity greater than 1,000 m/s.

341.07 CONSTRUCTION

341.07.01 General

Cracks shall be routed, cleaned, and sealed or cleaned and sealed as specified in the Contract Documents.

The router and cutter heads shall be maintained, operated, and replaced as required to prevent the shattering of aggregate along the sides and bottom of the rout.

341.07.02 Crack Routing

Cracks up to 20 mm in width shall be routed to the dimensions as specified in the Contract Documents.

All other cracks up to 20 mm in width discovered at the time of routing shall be routed with the exception of any alligator and map cracking as described in SP-024.

The routing of all transverse and skewed cracks shall be terminated within 25 mm of the pavement edge.

Two or more cracks shall not be joined by routing through uncracked pavement or routed in areas where a crack does not exist.

Cracks greater than 20 mm in width do not require routing.

341.07.03 Sealant Preparation

The sealant compound shall be melted slowly with constant agitation until it is in a lump-free, free-flowing state, within the temperature range recommended by the manufacturer for application.

Temperature gauges for both the heating oil and sealant on the kettle melter shall be properly calibrated at all times.

At the start of each day, the heating kettle is to be completely empty, clean and free of any residual material, prior to it being charged. The initial charge of the kettle with sealant shall be carried out in the presence of the Contract Administrator at a location acceptable to both the Contract Administrator and the Contractor.

The temperature of the sealant shall be monitored and recorded with the applicable date and time. The temperature records shall be made available to the Contract Administrator upon request.

341.07.04 Cleaning of Routed and Unrouted Cracks

Immediately prior to placing the sealant compound, all routed and unrouted cracks shall be cleaned and dried using a hot compressed air lance.

Before sealant application, all loose debris from the routing and cleaning operation shall be completely removed from the road surface. All moisture, debris, and loose fractured aggregate shall be removed from the routed and unrouted cracks immediately prior to the time the sealant compound is being placed.

341.07.05 Placing Sealant

Immediately following the cleaning of routed and unrouted cracks, the sealant compound shall be placed using either a manual pouring cone filled from a spigot located on the heating kettle itself, or by using a hose and wand fitted with the proper sized tip that allows the sealant to be pumped directly from the heating kettle into the routed or unrouted crack. The tip of the cone or wand shall be placed to the bottom of the crack to ensure uniform application.

For pavements that are to be overlaid with hot mix, all routed and unrouted cracks shall be filled with sealant so that, upon complete cooling, the top of the sealant is 4 to 6 mm below the adjacent pavement surface.

For all other pavements, all routed and unrouted cracks shall be filled with sealant so that, upon complete cooling, the sealant is no more than 1 mm below the adjacent pavement surface.

A squeegee, with its bottom edge trimmed to form the specified dimensions of the finished sealant surface after cooling, shall be used to strike off the sealant after it is poured into the routed or unrouted crack. The sealant shall be struck off starting from the low side and working towards the high side of the pavement surface.

In order to maintain the sealant surface dimensions, the sealant shall be topped up and struck off again prior to being dusted.

Sealant compound damaged by construction traffic or the Contractor's operation shall be replaced.

341.07.06 Sealant Dusting

Where traffic is to be maintained during crack sealing, the surface of the sealant shall be dusted with Portland cement or alternative materials acceptable to the Contract Administrator prior to allowing traffic on the sealed areas.

341.07.07 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

341.08 QUALITY ASSURANCE

341.08.01 Sampling and Testing Sealant

The Contract Administrator may require a sample of the sealant puck, approximately 4 litres in volume, from one or more batches of sealant. Such samples shall be placed in properly labelled suitable containers and submitted to the Contract Administrator.

At least once each hour, the temperature of the sealant shall be independently checked by the Contract Administrator. If the Contract Administrator finds that the temperature of the sealant is not within the manufacturer's recommended range, then all of the sealant that has been placed since the last acceptable temperature verified by the Contract Administrator shall be removed. Any sealant that is rejected shall be replaced with acceptable material.

During the process of placing, the Contract Administrator may require samples of the sealant directly from the heating kettle. A minimum of three 4-litre samples shall be taken from the heating kettle spigot at points when approximately 1/4, 1/2, and 3/4 of the proposed volume has been placed on the Contract. Additional samples may be requested by the Contract Administrator. All samples shall be placed in a properly labelled triple tight metal container.

All samples submitted to the Contract Administrator shall be labelled with the following information clearly shown:

a) Contract number.

b) Sealant type including the manufacturer and the product designation.

c) Manufacturer's batch number.

d) Roadway name.

e) Contractor and subcontractor.

f) The station and offset in the roadway where the sample was taken.

g) The point in the Contract at which the sample was taken (e.g., the percentage of work completed).

h) Sampling date.

i) Weather conditions.

j) Persons taking the sample.

341.08.02 Deficiencies and Repairs

Where a routed crack is found to be more than 10% outside the specified rout dimension, geometry, or location, it shall be considered unacceptable and corrected by additional routing.

Where the sealant subsides in the rout by more than 1 mm below the adjacent pavement surface, the surface of the sealant shall be cleaned and topped up. Where pavements are to be overlaid, if the surface of the sealant is greater than 6 mm below the adjacent pavement surface, the surface of the sealant shall be cleaned and topped up to between 4 mm and 6 mm.

Sealant shall be removed, the routed crack rerouted at the Contract Administrator's discretion, and the rout resealed, when the sealant:

a) contains imbedded foreign material other than dusting material,

b) contains entrapped air bubbles,

c) has debonded or pulled away from the routed crack, or,

d) has been excessively heated.

341.09 MEASUREMENT FOR PAYMENT

341.09.01 Actual Measurement

341.09.01.01 Routing, Cleaning, and Sealing Cracks in Hot Mix Asphalt Pavement

Measurement for payment shall be in linear metres along the routed, cleaned, and sealed crack.

Any portion of the sealed crack where the rout migrates away from the crack shall not be included in the measurement.

341.09.01.02 Cleaning and Sealing Unrouted Cracks in Hot Mix Asphalt Pavement

Measurement for payment shall be measured in linear metres along the cleaned and sealed unrouted crack.

341.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement is based on the units shown in the clauses under Actual Measurement.

341.10 BASIS OF PAYMENT

341.10.01 Routing, Cleaning, and Sealing Cracks in Hot Mix Asphalt Pavement - Item
Cleaning and Sealing Unrouted Cracks in Hot Mix Asphalt Pavement - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Sealant compound damaged by construction traffic or the Contractor's operation shall be replaced at no extra cost to the Owner.

Work to remove and replace sealant compound due to the sealant not being within the manufacturer's specified temperature range shall be completed at no extra cost to the Owner.

Work to remove and replace sealant compound to correct deficiencies and make repairs shall be completed at no extra cost to the Owner.

Appendix 341-A, November 2021
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- The quantity of routing and sealing of cracks and the quantity of cleaning and sealing of cracks. (341.07.01)

- Rout dimensions. (341.07.01)

Consideration for cracks to be routed and sealed include:

- Transverse and skewed cracks up to 20 mm in width.

- Longitudinal cracks up to 20 mm in width that are further than 150 mm from the pavement edge.

Consideration for cracks to be sealed without routing includes longitudinal cracks in fully or partially paved shoulders, within 150 mm of the pavement edge.

The designer may specify an overfill sealant geometry for transverse and skewed cracks. If overfill is desired, the designer should specify it in the Contract Documents.

Routing and sealing is recommended for the spring and fall months when crack widths are larger and the pavement surface temperature is less than 50 °C.

The designer should identify to the Owner the need for full-time inspection of the routing and sealing operations.

A pavement condition survey is recommended to determine the extent of routing and sealing or crack cleaning and sealing required.

The designer should ensure that the Ontario Provincial Standards General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 508.010	Routing and Sealing Cracks Up to 20 mm in Width in Asphalt Pavement

CONSTRUCTION SPECIFICATION FOR CONCRETE PAVEMENT AND CONCRETE BASE

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350-A **Commentary**

350.01 SCOPE

This specification covers the requirements for the construction of concrete pavement and concrete base.

350.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be as specified in Contract Documents.

350.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

350.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 314	Untreated Granular Subbase, Base, Surface, Shoulder and Stockpiling
OPSS 360	Full Depth Repair of Concrete Pavement and Concrete Base
OPSS 364	Partial Depth Repairs in Concrete Pavement
OPSS 369	Sealing or Resealing of Joints and Cracks in Concrete Pavement
OPSS 904	Concrete Structures
OPSS 905	Steel Reinforcement for Concrete
OPSS 914	Waterproofing Bridge Decks with Hot Applied Asphalt Membrane
OPSS 919	Formwork and Falsework

Ontario Provincial Standard Specifications, Material

OPSS 1002	Aggregates - Concrete
OPSS 1302	Water
OPSS 1305	Moisture Vapour Barriers
OPSS 1306	Burlap
OPSS 1308	Joint Filler (Concrete)
OPSS 1315	White Pigmented Curing Compounds for Concrete
OPSS 1350	Concrete - Materials and Production
OPSS 1441	Load Transfer Assemblies
OPSS 1442	Epoxy Coated Steel Reinforcement for Concrete

CSA Standards

CSA A23.1/.2-2019 Concrete Materials and Methods of Concrete Construction/Methods of Test for Concrete

350.03 DEFINITIONS

For the purposes of this specification the following definitions shall apply:

Certificate of Approval for a Waste Management System means as per R.R.O. 1990, Reg. 347: General – Waste Management.

Concrete Pavement means a rigid pavement structure with an exposed concrete surface which may include concrete shoulders.

Concrete Base means a rigid pavement structure which is overlaid with asphaltic concrete, on the same contract, and may include concrete shoulders.

Effluent means liquid that is a direct result of concrete grinding and grooving. Effluent includes any stormwater, or surface drainage that becomes mixed with this material. Effluent is classified as liquid industrial waste Class 146(L).

350.04 DESIGN AND SUBMISSION REQUIREMENTS

350.04.01 Design Requirements

A plan detailing the curing and protection plans shall be submitted. The plan shall describe the method by which in-place minimum or maximum concrete temperatures shall be maintained. No concrete shall be placed unless the plan is approved by the Contract Administrator.

350.04.02 Submission Requirements

Prior to starting the work, documentation shall be submitted, verifying that the Contractor's representative of the placing crew shall be on site and shall have the certification as specified in Contract Documents.

350.04.02.01 Effluent Management

All approvals, releases, and agreements, and conditions that are required for effluent management shall be obtained prior to the commencement of the effluent producing work.

Effluent shall be transported to one of the following receiving sites:

a) A waste disposal site with a Certificate of Approval for a Waste Disposal Site valid for liquid industrial waste Class 146 (L).

b) A waste processing facility with Certificate of Approval for a Waste Disposal Site (Processing) valid for liquid industrial waste Class 146 (L).

A written agreement from the operator of the receiving site or property owner selected to accept the effluent, as well as their Certificate of Approval for a Waste Disposal Site, shall be submitted to the Contract Administrator a minimum of two weeks prior to commencement of the effluent producing work.

A copy of the Certificate of Approval for a Waste Management System shall be submitted to the Contract Administrator prior to the commencement of the effluent producing work.

350.05 MATERIALS

350.05.01 Concrete

Concrete and concrete materials shall be according to OPSS 1350 with the following amendments:

a) The coarse aggregate for concrete pavement and concrete base shall have a combined gradation of nominal maximum size 37.5 mm and 19.0 mm aggregate, and shall be according to OPSS 1002.

b) Concrete shall be according to OPSS 1350, with a minimum specified 28-Day compressive strength of 32 MPa, Class C-2 Exposure.

c) Maximum slag content shall be 25%.

350.05.02 Burlap

Burlap shall be according to OPSS 1306.

350.05.03 Moisture Vapour Barrier for Curing

Moisture vapour barrier for curing shall be according to OPSS 1305.

350.05.04 Curing Compound

White pigmented membrane curing compound for concrete shall be according to OPSS 1315.

350.05.05 Water for Curing

Water for curing shall be according to OPSS 1302.

350.05.06 Tie Bars and Load Transfer Devices

Tie bars shall be according to OPSS 1442 and load transfer devices shall be according to OPSS 1441.

350.05.07 Joint Materials

Expansion joint filler shall be according to OPSS 1308.

Joint sealant material shall be according to OPSS 369.

350.06 EQUIPMENT

350.06.01 Consolidation

Concrete shall be consolidated by means of surface vibrators, internal vibrators, or a combination of both that provide full depth consolidation without segregation.

350.06.02 Hot Poured Rubberized Asphalt Joint Sealing

Hot poured rubberized asphalt joint sealing equipment shall be according to OPSS 914.

350.06.03 Forms

Forms shall be according to OPSS 919.

350.06.04 Automatic Dowel Bar Inserter

Where an automatic dowel bar inserter is used, it shall be capable of placing dowel bars as specified in Contract Documents. The dowel bars shall be inserted to mid-depth of the slab and centred on the transverse joint locations and spaced as shown on the plans. The equipment shall be capable of consolidating the concrete around the dowel bars.

350.06.05 Diamond Grinder

Grinding equipment that causes raveling, aggregate fractures or disturbance to the joints shall not be permitted.

The diamond grinder shall be power-driven, self-propelled equipment specifically designed to grind and texture concrete surfaces. It shall be equipped with a grinding head with at least 50 diamond blades per 300 mm of shaft. The grinding head shall be at least 0.9 m wide. The grinder shall have the capability to adjust the depth, slope, and cross-fall to ensure that concrete is removed to the desired dimensions and uniformly feathered and textured across the width, and length of the repair area.

350.07 CONSTRUCTION

350.07.01 Preparation Work

350.07.01.01 General

Before placing concrete on granular base, the granular immediately ahead of the concrete placing operation shall be wetted down thoroughly. The wetting down shall be carried out without leaving standing water.

350.07.02 Joints

350.07.02.01 General

Type and location(s) of joints shall be as specified in the Contract Documents.

The initial saw cut, for longitudinal and transverse contraction joints, shall be cut as soon as possible, normally within 12 hours of paving operations. Saw cutting operations shall not result in ravelling or other damage to the concrete. The initial cut shall be for one third the depth of the concrete slab.

The joints shall be cleaned and sealed according to OPSS 369.

Dowel bars at the transverse contraction joints shall be placed using load transfer devices or an automatic dowel bar inserter.

350.07.02.02 Load Transfer Devices

Load transfer devices shall be as specified in the Contract Documents.

350.07.02.03 Transverse Construction Joints

Transverse construction joints shall be made at the end of each day's run or when interruptions occur in the concreting operation. Transverse construction joints shall be formed at a contraction or expansion joint, except in exceptional cases of plant breakdown or adverse weather conditions. In these exceptional cases, a construction joint may be formed in the mid slab area subject to the provision that the portion of the slab placed and the portion of the slab to be placed, is not less than 2 m in length. Construction joints in adjacent lanes of pavement shall align with joints in the previously placed lane.

350.07.02.04 Position and Alignment Tolerances

350.07.02.04.01 Dowel Bars

The dowel bars shall be placed within a tolerance of ± 6 mm in the vertical and horizontal planes of the pavement.

The dowel bars shall not be skewed and shall be perpendicular to the face of the joint.

Skewed joints, where applicable, shall be as specified in the Contract Documents.

350.07.02.04.02 Joints

All joints shall be placed within a tolerance of ± 15 mm from the position and alignment of the centre of the dowel bars.

350.07.02.05 Tie Bars

At longitudinal joints, epoxy coated tie bars shall be installed as specified in the Contract Documents. Tie bars shall be inserted so that voids are not created around the bar. Tie bars shall not be placed within 600 mm of a transverse joint.

350.07.02.06 Dowel Bars at Transverse Joints

At all expansion and contraction joints, dowel bars shall be installed as specified in the Contract Documents. The location of dowel bars shall be marked to permit precise joint forming or cutting operations directly over the centre of the dowel bars.

Automatic dowel bars, where used, shall be as specified in the Contract Documents.

350.07.02.07 Protection of Tie Bars and Dowel Bars

Protection of dowel bars shall be according to OPSS 905.

Bars with coating damage greater than 5% of the surface area of each bar shall not be used.

For bars with coating damage of 1% or less of their surface area, all damaged areas, including ends, of the bar coating shall be repaired.

350.07.03 Concrete Placement

Concrete shall be placed at or near its permanent location in such a manner to avoid segregation of the materials. Any excess concrete beyond the pavement edge shall be removed immediately.

Transverse joint load transfer devices shall be laid out and material in place at a minimum of 100 m in advance of the paving operations.

When an interruption in placing concrete of more than 45 minutes occurs, a transverse construction joint shall be formed.

350.07.03.01 Consolidating

Concrete shall be thoroughly consolidated against and along the face of all forms and into the face of previously placed concrete.

For fixed-form placement, hand-held vibrators shall be used to supplement consolidation adjacent and along the full length of the form. They shall also be inserted at regularly spaced intervals along both sides of dowel assemblies. Vibrators shall never be operated longer than 15 seconds in any one location.

For slip-form pavers, the concrete shall be consolidated by vibrators of sufficient number, spacing, and frequency to provide uniform consolidation to the entire pavement width and depth. The vibrators shall not operate while the paver is stopped.

For all methods, vibrators shall not come in contact with the subgrade, subbase, forms, tie bars or dowel assemblies.

350.07.03.02 Finishing

Finishing of the concrete surface shall take place while the concrete is sufficiently plastic to achieve the desired grades, elevations, and texture, according to CSA A23.1.

The surface of the concrete shall be uniform, dense, free from undulations and projections, struck off true to grade and cross-section, and finished with a magnesium or aluminum float.

Care shall be taken to avoid over finishing or working more mortar to the surface than is required.

Excessive fines and water shall not be drawn to the surface.

Surface evaporation retardants shall not be used as an aid for finishing concrete.

The application of water, cement, or combination of both to the concrete surface shall not be permitted as a finishing aid.

Localized defects shall be repaired using concrete.

350.07.03.03 Texturing of Surface

After all finishing operations are completed on concrete pavements, and before initial curing and protection of the concrete, the plastic surface of the concrete shall receive an initial and final texturing as specified in the Contract Documents.

The surface shall be free in all cases from displaced aggregate particles and local projections.

The Contract Administrator shall immediately be notified in writing if any of the defects or conditions listed in the Acceptance of Concrete Surface Texturing subsection are present in the work and shall include the extent of the defects and an explanation of the cause. A proposal for the remedial work for the above defects and conditions shall be submitted to the Contract Administrator for review. The repairs shall not proceed until approval of the proposal has been received from the Contract Administrator. Repairs shall be at no additional cost to the Owner.

350.07.03.04 Surface Tolerance

The surface of the concrete is to be such that when tested with a 3 m long straightedge placed in any location and direction, including the edge of pavement, except across the crown or drainage gutters, there shall not be a gap greater than 3 mm between the bottom of the straightedge and the surface of the pavement.

Diamond grinding shall be required to ensure the concrete surface meets these requirements.

350.07.03.05 Diamond Grinding

The pavement shall be ground in a longitudinal direction, in the normal traffic direction.

The diamond ground surface shall be free of corrugations due to out-of-round wheels on grinding equipment or improper operation of the cutting head, and depressions due to improper starting and stopping during the grinding operation. There shall be no fractured aggregate at the ground surface.

The maximum combined depth of diamond grinding to correct deficiencies, including all grinding passes, shall be 10 mm.
The diamond grinding process shall maintain the existing longitudinal profile and maintain positive surface drainage.

The surface finish shall be closely monitored and shall immediately take necessary control or corrective action as work progresses.

350.07.04 Curing

350.07.04.01 General

Curing shall be according to OPSS 904 with the following exceptions:

Curing shall be applied to all exposed surfaces as soon after the texturizing operation as can be achieved without damaging the surface.

As soon as forms are removed, the sides of the exposed concrete faces shall be sprayed with the white pigmented curing compound at the specified application rate according to the manufacturers specifications or as specified in the Contract Documents. Curing compound that is applied to joint faces shall be removed prior to receiving sealant.

350.07.05 Joint Sealing

Joint sealing shall be according to OPSS 369.

350.07.06 Miscellaneous Protection

350.07.06.01 Rain

Concrete shall not be placed in the rain. Necessary precautions shall be taken to protect plastic concrete from rain.

350.07.06.02 Traffic

Traffic, other than foot traffic, rubber-tired sawing equipment, and rubber-tired side wheels of form mounted placing and finishing equipment necessary to construct adjacent lanes, shall not be permitted on the concrete until it has attained 20 MPa.

For early opening determination, samples required for early strength determination shall be taken and tested. A minimum of one set of two cylinders per 500 m length of paving shall be required. Samples shall remain on site until time of testing.

The concrete pavement shall always be protected from damage to the surface when steel-tracked equipment is used.

350.07.06.03 Shoulders

Shouldering operations may commence once the adjacent concrete has attained 20 MPa. Completion of the shoulders shall be according to OPSS 314.

350.07.06.04 Cold and Hot Weather

The placing and protection for cold weather concrete shall be according to OPSS 904.

Where the ambient air temperature exceeds 28 ^{o}C and the concrete temperature exceeds 25 ^{o}C, the discharge time shall be reduced to a maximum of one hour after the introduction of mixing water. Concrete shall not be placed in ambient air temperatures exceeding 35 ^{o}C.

350.07.06.04.01 Insulation Removal for Saw Cutting

When the concrete pavement or concrete base requires protection by insulation, no more than 25 linear metres of concrete pavement or concrete base shall be exposed for saw cutting operations at any one time. In no case shall any concrete pavement or concrete base be exposed for more than one hour during saw cutting.

350.07.07 Concrete Base

350.07.07.01 General

The work required for concrete base includes the work required for concrete pavement except as modified by this subsection.

350.07.07.02 Joints

A final reservoir cut is not required at the joints.

350.07.07.03 Texturing of Surface

Texturing of the surface is not required.

350.07.07.04 Joint Sealing

The sealing of joints in concrete base is not required.

350.07.07.05 Surface Tolerance

The provisions of Surface Tolerance clause of this specification apply, except that the tolerance is increased to 6 mm.

350.07.08 Management of Effluent from Concrete Grinding and Grooving Operations

350.07.08.01 General

Effluent shall be captured and managed as specified in the Contract Documents.

These requirements do not supersede the obligations imposed by the Contractor's Certificate of Approval for a Waste Management System.

For each shipment of effluent from the construction area to the certified receiving site:

a) The carrier shall have a Certificate of Approval for a Waste Management System valid for liquid industrial waste Class 146 (L), and shall comply with the Carrier Information and Certificate of Approval clauses; and

b) The shipment shall be manifested as specified in the Manifesting clause.

For materials resulting from concrete removal, and materials resulting from concrete repair/construction, appropriate measures including providing such protection system or systems shall be taken to ensure that such materials do not fall into or enter the waterbody or, cause damage to any portion of the pavement structure not designated for removal.

For concrete saw cutting, grooving, or grinding, the appropriate measures including providing such protection system or systems shall be taken to contain any removed material until it is disposed of; and minimize the escape of dust such that no visible dust reaches the waterbody, adjacent wetlands, or property outside the right-of-way limits.
At the completion of the work, a copy of a release signed by the same receiving site operator or property owner shall be submitted to the Contract Administrator.

350.07.08.02 Carrier Information

The carrier shall have a Certificate of Approval for a Waste Management System valid for liquid waste Class 146 (L).

Responsibilities of certified carriers shall include, but not be limited to, the following:

a) Transportation of waste materials produced by the work according to the Certificate of Approval;

b) Responsible for the waste materials including, but not restricted to, manifesting of liquid industrial waste.

350.07.08.03 Certificate of Approval

The Certificate of Approval for a Waste Management System and the receiver's Certificate of Approval for a Waste Disposal Site shall be provided and be valid for the following:

a) The entire period of the work;

b) The entire area within the limits of the work and the entire haul route; and

c) The equipment to be used; and

d) Waste classification 146 (L).

350.07.08.04 Manifesting

A Regulation 347 Form 1 manifest for "Part A" shall be presented on behalf of the carrier to the Contract Administrator.

The Contract Administrator shall be notified a minimum of two weeks prior to the first shipment requiring manifesting, and a minimum of 24 hours' notice prior to each subsequent shipment requiring manifesting.

350.08 QUALITY ASSURANCE

350.08.01 Sampling and Testing

350.08.01.01 Criteria for Determining Unacceptable Concrete

If the tests on cylinders do not show a nominal minimum 28-day compressive strength of 32 MPa, the area represented by the cylinders shall be removed and replaced.

350.08.01.02 Compressive Strength

Testing of compressive strength shall be according to OPSS 1350.

350.08.01.03 Slump and Air Content

Field sampling and testing of plastic concrete for conformance to slump and air content requirements shall be the responsibility of Contract Administrator, as detailed below.

Testing of slump and air content shall be according to OPSS 1350.

The frequency of slump and air content testing shall be according to Table 1.

350.08.01.04 Removal of Unacceptable Concrete

The frequency of compressive strength testing shall be for each load tested according to Table 1.

If results for compressive strength of concrete pavement or concrete base dictates removal and replacement cores shall be taken to establish the extent of the deficient area.

The area to be removed shall be bounded by the nearest contraction joint and longitudinal joint or concrete pavement or concrete base edge outside the deficient area so that there shall be no additional joints.

350.08.01.05 Cracking in Concrete Pavement

All cracking, in excess of one third the depth of the slab thickness shall be repaired as a full depth repair according to OPSS 360.

Cracks less than one-third the thickness of the slab shall be repaired according to OPSS 364.

350.09 MEASUREMENT FOR PAYMENT

350.09.01 Actual Measurement

350.09.01.01 Concrete Pavement or Concrete Base

Measurement shall be the surface area of concrete pavement or concrete base placed in square metres.

350.09.02 Plan Quantity Measurement

350.09.02.01 Concrete Pavement or Concrete Base

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clause under Actual Measurement.

350.10 BASIS OF PAYMENT

350.10.01 Concrete Pavement - Item
Concrete Base - Item

Payment at the contract price for the above tender items shall be full compensation for all labour, Equipment and Material to do the work.

350.10.01.02 Additional Coring and Testing

Payment shall not be made for additional coring and testing to determine the limits of slab removal for unacceptable concrete.

Table 1
Sampling and Testing - Minimum Frequencies

Tests	**Frequency**
Air Content	A minimum of three loads or until satisfactory control is established. Then 1 random test per 5 truck loads
Slump for Fixed Form Paving	A minimum of three loads or until satisfactory control is established. Then 1 random test per 5 truck loads
Notes: Test Procedures shall be according to CSA A23.2 Satisfactory control is considered to have been established when tests on three consecutive truck loads or batches of concrete are within specification requirements.	

Appendix 350-A, November 2021
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Certification such as Municipal Exterior Flatwork Certification, or ACI Flatwork Certification, or approved equivalent. Where ACI Flatwork Certification means the certification issued by the American Concrete Institute, after demonstrating knowledge and the ability to place, consolidate, finish, edge, joint, cure and protect concrete flatwork. And where Municipal Exterior Flatwork Certification means the certification issued by Ready Mixed Concrete Association of Ontario (RMCAO), after demonstrating knowledge to place, consolidate, finish, edge, joint, cure and protect concrete flatwork. (350.04)

- Dowel bars. (350.06.04)

- Load transfer devices. (350.07.02.02)

- When skewed joints are to be used, consider OPSD 552.050. (350.07.02.04.01)

- Epoxy coated tie bars. (350.07.02.05)

- When an automatic dowel bar inserter is used, the Contractor shall be required to remove a 2 m x full paver width section of concrete pavement or concrete base within the first days paving. Additional sections will be required until the Contractor's operations conform to the specification. The joint to be removed will be selected by the Contract Administrator. The section will be inspected by the Contract Administrator to ensure that the placement and alignment of the dowel bars meet requirements. The section removed shall be repaired according to OPSS 360. (350.07.02.06)

- Initial texturing may be performed with a longitudinal burlap drag to produce a uniform textured surface. Burlap shall be kept in a clean and damp condition, free from encrusted mortar. (350.07.03.03)

- Final texturing options include (but not limited to): Grooving, Tining, Broom Finish, or Burlap Finish. (350.07.03.03)

- When transverse tining is specified for final texturing it shall be achieved using equipment manufactured to produce transverse tining on maximum 16 mm $\pm$ 3 mm centres with a tining depth of 4 mm $\pm$ 1 mm. Tining shall extend to within 75 mm $\pm$ 15 mm of the pavement edge. Tining for small or irregular areas may be done by hand methods. (350.07.03.03)

- When longitudinal grooving is specified as final texture, the pavement surface shall be grooved with a grooving machine longitudinally at are as specified in Contract Documents or as directed by the Contract Administrator. Longitudinally grooved areas shall be straight and run parallel to the longitudinal axis of the pavement, begin and end at lines radial to the pavement center line and shall be centered within the lane width, unless otherwise specified in the Contract Documents. (350.07.03.03)

- The pavement shall be grooved to the full width of the lane under construction within the station-to-station limits established by the Contractor during each shift. (350.07.03.03)

- Grooves shall be cut 2.5 mm in width, with a tolerance of plus 1.5 mm, and between 3.0 and 6.0 mm in depth. Over inductive loop detectors, grooves shall be cut between 1.5 and 3.0 mm in depth. Grooves shall have a centre-to-centre spacing of 19 mm with a tolerance of plus or minus 2.5 mm. Grooves shall

be cut to within 150 mm and no closer than 50 mm of longitudinal joints. (350.07.03.03)

- Grooving that results in ravelling, aggregate fractures, spalls, or disturbance to the transverse or longitudinal joints, shall not be permitted and shall be controlled or corrected immediately as the work progresses. (350.07.03.03)

- If during the course of the work, a single grooving blade on any individual grooving machine becomes incapable of cutting a groove within the specified tolerances, work will be permitted to continue for the remainder of the work shift and the Contractor will not be required to otherwise recut the groove. Should two or more grooving blades on any individual grooving machine become incapable of cutting grooves within the specified tolerances, the Contractor shall cease operations with this machine until repairs are effected. (350.07.03.03)

- Specified application rate of curing compound (350.07.04.01)

- Effluent from concrete grinding and grooving operations (350.07.08.01)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

CONSTRUCTION SPECIFICATION FOR CONCRETE SIDEWALK

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351-A **Commentary**

351.01 SCOPE

This specification covers the requirements for the construction of concrete sidewalks.

351.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be as specified in the Contract Documents.

351.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

351.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 206	Grading
OPSS 314	Untreated Granular, Subbase, Base, Surface, Shoulder and Stockpiling
OPSS 408	Adjusting or Rebuilding Maintenance Holes, Catch Basins, Ditch Inlets, and Valve Chambers
OPSS 501	Compacting
OPSS 904	Concrete Structures
OPSS 919	Formwork and Falsework

Ontario Provincial Standard Specifications, Material

OPSS 1010	Aggregates - Base, Subbase, Select Subgrade, and Backfill Material
OPSS 1212	Hot Poured Rubberized Asphalt Joint Sealing Compound
OPSS 1308	Joint Filler in Concrete
OPSS 1315	White Pigmented Curing Compounds for Concrete
OPSS 1350	Concrete - Materials and Production

CSA Standards

A23.1-19	Concrete materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete

ASTM International

C171-07 Sheet Materials for Curing Concrete
A48M-03 Gray Iron Castings

351.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Cold Weather means as defined in OPSS 904.

Hot Weather means as defined in OPSS 1350.

Sidewalk Bay means the area between two transverse joints, regardless of the type of joint.

351.04 DESIGN AND SUBMISSION REQUIREMENTS

351.04.02 Submission Requirements

351.04.02.01 General

Prior to starting the work, documentation shall be submitted, verifying that the Contractor's representative of the placing crew shall be on site and shall have the certification as specified in Contract Documents.

351.04.02.02 Tactile Walking Surface Indicator Plate Submission Requirements

One copy of the manufacturer's installation instructions and Working Drawings for each type of tactile walking surface indicator plates shall be submitted to the Contract Administrator prior to the installation of the plates.

When requested, a certificate from the manufacturer for the tactile walking surface indicator plates that confirms the product was manufactured and met the test requirements according to the Contract Documents shall be submitted to the Contract Administrator. The certificate shall include test results from an independent testing laboratory currently accredited by the Standards Council of Canada.

351.05 MATERIALS

351.05.01 Concrete

Concrete shall be according to OPSS 1350, with a minimum specified 28-Day compressive strength of 32 MPa, Class C-2 Exposure. Coarse aggregate for the concrete shall have a nominal maximum size of 19.0 mm.

351.05.02 Expansion Joint Material

Expansion joint filler material shall be asphalt impregnated fibreboard having a minimum of 12 mm thickness and shall be according to OPSS 1308, Type A.

Hot poured rubberized asphalt joint sealing compound shall be according to OPSS 1212.

351.05.03 Subgrade Moisture Vapour Barrier

Subgrade moisture vapour barrier shall be according to ASTM C171.

351.05.04 Granular

Granular base shall be according to OPSS 1010.

351.05.05 Curing Compound

Curing compound shall be according to OPSS 1315.

351.05.06 Tactile Walking Surface Indicator Plates

Cast iron tactile walking surface indicator plates shall be as specified in the Contract Documents. Castings shall be according to ASTM A48M, Class 35B, and shall be bare and not coated with paint or other coatings or substances. Castings shall be sound, free from pouring faults, cracks, blowholes, and other defects.

The initials or trademark of the manufacturer, year of manufacture, and country of manufacture shall be distinctly cast and legible in raised letters on the top side of each plate.

351.05.07 Alternate Material

Where alternate material (instead of cast iron) is to be used, it shall be as specified in the Contract Documents.

351.06 EQUIPMENT

351.06.01 Forms

Forms shall be according to OPSS 919.

351.06.02 Slip Forming

The equipment used for slip forming shall have automatic horizontal and vertical alignment controls shall be used in conjunction with at least one stringline.

351.07 CONSTRUCTION

351.07.01 General

The work required for concrete sidewalk shall include earthwork, granular base, compaction, preparation work, formwork, Utility adjustment and isolation, concrete placing and finishing, jointing, curing, and protection.

Concrete sidewalk shall be constructed at the locations and to the widths and thicknesses specified in the Contract Documents.

Excavation and embankment construction shall be according to OPSS 206.

351.07.02 Grading Tolerances

351.07.02.01 Subgrade

When the subgrade is prepared for:

a) granular base, the finished subgrade surface shall be within a 15 mm deviation measured at any point on a 3 m long straight edge.

b) sidewalk, the finished subgrade surface shall be within a 12 mm deviation from the specified grade and cross-section, with the surface being within a 10 mm deviation measured at any point on a 3 m long straight edge.

351.07.02.02 Granular Base

Placement of granular base material shall be according to OPSS 314.

When a granular base is prepared for sidewalk, the finished granular surface shall be within a 12 mm deviation from the specified grade and cross-section, with the surface being within a 10 mm deviation measured at any point on a 3 m long straight edge.

351.07.03 Compaction

Compaction shall be according to OPSS 501.

351.07.04 Preparation Work

Before placing concrete on:

a) subgrade, the subgrade shall be wetted down, except where clays occur.

b) granular base, the granular immediately ahead of the concrete placing operation shall be wetted down thoroughly.

The wetting down shall be carried out without leaving standing water.

Alternatively, a subgrade moisture vapour barrier may be placed to completely cover the subgrade under the sidewalk. Adjacent strips shall be lapped 100 mm minimum and ends shall be lapped 300 mm minimum.

351.07.05 Form Setting

Throughout their entire length, forms shall be set true to the lines, grades, and thickness specified in the Contract Documents and in direct contact with the subgrade or granular base.

351.07.06 Utility Adjustment

Work done on adjustment of maintenance holes, valve chambers, and catch basins shall be according to OPSS 408. Utilities shall be adjusted flush with the surface of the new sidewalk.

Utilities maintained by third-parties other than the Owner shall be adjusted by the third-party companies concerned under arrangement by the Contract Administrator.

The edge of the Utilities shall be excavated and the required grade of the new sidewalk shall be indicated.

351.07.07 Utility Isolation in Sidewalk

The required Utility isolations shall be constructed in the concrete sidewalk to the details and at the locations specified in the Contract Documents.

351.07.08 Placing Concrete

Concrete shall be placed and consolidated according to CSA A23.1. Any excess concrete beyond the sidewalk edge shall be removed. Concrete shall be placed by a continuous pour method. Where concrete placing is interrupted for more than 45 minutes a 12 mm thick asphalt impregnated fibreboard joint filler

shall be installed vertically full depth across the sidewalk width, to form an expansion joint, before resuming concrete placing.

Concrete shall not be placed against any material which is at a temperature above 35 °C or against any material whose temperature is below 0 °C.

351.07.09 Tactile Walking Surface Indicator Plate Installation

A set of two cast iron tactile walking surface indicator plates shall be set into wet prepared concrete at each concrete sidewalk ramp as specified in the Contract Documents and according to the plate manufacturer's installation instructions.

Plates shall be cleaned after installation.

351.07.10 Concrete Finishing

Finishing of the concrete surface shall take place while the concrete is sufficiently plastic to achieve the desired grades, elevations, and texture, according to CSA A23.1.

The surface of the sidewalk shall be uniform, dense, free from undulations and projections, struck off true to grade and cross-section, and finished with a magnesium or aluminum float.

Care shall be taken to avoid over finishing or working more mortar to the surface than is actually required.

Excessive fines and water shall not be drawn to the surface.

Surface evaporation retardants shall not be used as an aid for finishing concrete.

The application of water, cement, or combination of both to the concrete surface shall not be permitted as a finishing aid.

Localized defects shall be repaired using concrete.

The sidewalk shall be given a broomed texture after finishing with a magnesium or aluminum float.

The concrete adjacent to all formwork shall be finished with a tool that produces a 5 mm rounded edge and a smooth, horizontal surface with a maximum width of 50 mm. All tooling shall be uniform and straight and shall be depressed no more than 1 mm below the adjacent surface. Any ridges along the tooled marks shall be removed. Contraction and expansion joints shall not be finished with a tooled edge.

The presence of footprints or other marks in the completed sidewalk shall require saw cutting, removal, and replacement of the complete sidewalk bay.

351.07.11 Joints

351.07.11.01 General

Longitudinal and transverse joints shall be constructed of the type and at the locations specified in the Contract Documents.

351.07.11.02 Dummy Joints

Dummy joints shall be formed when specified in the Contract Documents.

351.07.11.03 Contraction Joints

Contraction joints shall be placed at a maximum of 4.5 m spacing. and shall be saw cut or formed to a depth that is one quarter the thickness of the sidewalk.

When the sidewalk width is 2.5 m or greater, a longitudinal contraction joint shall be sawn or formed at a maximum spacing interval of 1.5 m.

351.07.11.04 Expansion Joints

Expansion joints shall be constructed to the full depth of the sidewalk.

Expansion joints shall be filled full depth with 12 mm thick asphalt impregnated fibreboard joint filler material and shall be clean and dry at the time of construction.

Isolation joints shall be constructed full depth where the sidewalk abuts a rigid object or changes direction.

351.07.11.05 Construction Joints

At the end of each day's work, or in the event of an unavoidable stoppage of concrete placement extending more than 45 minutes, an expansion joint shall be constructed at the planned location of a joint.

351.07.12 Identification Stamp

At the request of the Contract Administrator, the sidewalk shall be clearly and legibly marked with an approved stamp each end of the work, and at other places as directed. The stamp shall be centred on the sidewalk bay next to and parallel to a transverse joint. The stamp shall identify the Contractor's name and the year of construction.

351.07.13 Concrete Curing

Concrete curing shall be according to OPSS 904.

351.07.14 Cold Weather Concreting

The placing and protection of concrete sidewalks in cold weather shall be according to OPSS 904.

351.07.15 Hot Weather Concreting

Where the air temperature exceeds 28 ^{o}C and the concrete temperature exceeds 25 ^{o}C, the discharge time shall be reduced to a maximum of one hour after the introduction of mixing water. Concrete shall not be placed in air temperatures exceeding 35 ^{o}C.

351.07.16 Protection of Sidewalk

Vehicular traffic, including construction equipment, shall be restricted from crossing the sidewalk after the concrete has been placed for a minimum period of three days or until the concrete has attained 20MPa.

351.07.17 Sidewalk Tolerances

The surface of the concrete, after texturing, shall be within a 6 mm deviation measured at any point on a 3 m long straight edge.

The minimum acceptable thickness of the sidewalk shall be the specified thickness minus 8 mm. If the thickness deficiency exceeds 8 mm, the sidewalk shall be removed and replaced.

Core samples of the finished concrete may be taken to establish the actual thickness of the slab at locations determined by the Contract Administrator.

Unacceptable areas of sidewalk identified by the Contract Administrator shall require the saw cutting, removal, and replacement of the complete sidewalk bay.

351.07.18 Tactile Walking Surface Tolerances

Tolerances for the tactile walking surface indicator plates shall be as specified in the Contract Documents. If the tactile walking surface indicator plates are not within the specified tolerances, the plates shall be rejected.

Rejected plates shall be removed and replaced as directed by the Contract Administrator.

351.07.19 Field Sampling and Testing of Concrete

Field sampling and testing of concrete shall be according to OPSS 1350.

351.07.20 Management of Excess Material

Management of excess material shall be as specified in the Contract Documents.

351.09 MEASUREMENT FOR PAYMENT

351.09.01 Actual Measurement

351.09.01.01 Concrete Sidewalk

Measurement of concrete sidewalk shall be by area in square metres.

351.09.01.02 Tactile Walking Surface Indicators for Concrete Sidewalk Ramps

For measurement purposes a count shall be made for each tactile walking surface indicator plates installed at each concrete sidewalk ramp.

351.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clause under Actual Measurement.

351.10 BASIS OF PAYMENT

351.10.01 Concrete Sidewalk - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

Repair or removal and replacement of an unacceptable sidewalk bay shall be completed at no extra cost to the Owner.

351.10.02 Tactile Walking Surface Indicators for Concrete Sidewalk Ramps – Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

351.10.03 Excavation

Payment for excavation shall be under the tender item Earth Excavation, Grading or Rock Excavation, Grading according to OPSS 206.

351.10.04 Utility Adjustment

Payment for the adjustment of Utilities shall be paid under the appropriate items according to OPSS 408.

No payment shall be made for utilities adjusted by third-party companies.

Appendix 351-A, November 2021
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Certification such as Municipal Exterior Flatwork Certification, or ACI Flatwork Certification, or approved equivalent. Where ACI Flatwork Certification means the certification issued by the American Concrete Institute, after demonstrating knowledge and the ability to place, consolidate, finish, edge, joint, cure and protect concrete flatwork. And where Municipal Exterior Flatwork Certification means the certification issued by Ready Mixed Concrete Association of Ontario (RMCAO), after demonstrating knowledge to place, consolidate, finish, edge, joint, cure and protect concrete flatwork. (351.04.02)

- Alternate tactile plates' material details (351.05.07)

- Locations of sidewalks wider than 1.5m in areas with higher pedestrian volumes (see TAC GDG, Section 2.2.6.5 and MTO GDSOH, Section D.8.4) (351.07.01)

- Line, grade, and thickness requirements of concrete sidewalk (351.07.01 and 351.07.05)

- Details and locations of required Utility isolations (351.07.07)

- Designer shall specify if Dummy Joints are required. (351.07.11.02)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

The curved plates should only be used with drop-curb settings.

According to the Canadian National Institute for the Blind (CNIB), as of 2019, it is understood that the alignment of tactile plates DO NOT indicate direction.

Related Ontario Provincial Standard Drawings

OPSD 310.010	Concrete Sidewalk
OPSD 310.020	Concrete Sidewalk Adjacent to Curb and Gutter
OPSD 310.030	Concrete Sidewalk Ramps at Intersections
OPSD 310.031	Concrete Sidewalk Ramps at Signalized Intersections with Intersecting Crosswalks
OPSD 310.033	Concrete Sidewalk Ramps at Unsignalized Intersections
OPSD 310.039	Concrete Sidewalk Ramps Tactile Walking Surface Indicators Component
OPSD 310.040	Utility Isolation in Concrete Sidewalks
OPSD 310.050	Concrete Sidewalk Driveway Entrance Details
OPSD 310.060	Joint Detail for Concrete Pedestrian Crosswalk at Signalized Intersection

CONSTRUCTION SPECIFICATION FOR CONCRETE CURB AND GUTTER SYSTEMS

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353-A **Commentary**

353.01 SCOPE

This specification covers the requirements for the construction of concrete curb and gutter, setbacks, gutter outlets, and bullnoses together with the installation of catch basin frames and grates which lie within the flow lines of the curb and gutter system.

353.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be as specified in the Contract Documents.

353.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

353.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 206	Grading
OPSS 314	Untreated Granular Subbase, Base, Surface Shoulder, and Stockpiling
OPSS 350	Concrete Pavement and Concrete Base
OPSS 407	Construction of Maintenance Hole, Catch Basin, Ditch Inlet, and Valve Chamber Installation
OPSS 501	Compacting
OPSS 904	Concrete Structures
OPSS 905	Steel Reinforcement for Concrete
OPSS 919	Formwork and Falsework

Ontario Provincial Standard Specifications, Material

OPSS 1212	Hot Poured Rubberized Asphalt Joint Sealing Compound
OPSS 1308	Joint Filler in Concrete
OPSS 1315	White Pigmented Curing Compounds for Concrete
OPSS 1350	Concrete - Materials and Production
OPSS 1440	Steel Reinforcement for Concrete
OPSS 1850	Frames, Grates, Covers, and Gratings

CSA Standards

A23.1-19 Concrete materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete

353.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Cold Joint means as defined in OPSS 904

Cold Weather means as defined in OPSS 904.

Concrete Pavement means concrete pavement or concrete base.

Curb and Gutter means curb, gutter, or combinations of curb and gutter.

Curb and Gutter Systems means curb and gutter, setbacks, gutter outlets, concrete spillways, bullnoses, or any combination of them.

Hot Weather means as defined in OPSS 1350.

353.04 DESIGN AND SUBMISSION REQUIREMENTS

353.04.01 Submission Requirements

Prior to starting the work, documentation shall be submitted, verifying that the Contractor's representative of the placing crew shall be on site and shall have the certification as specified in the Contract Documents.

353.05 MATERIALS

353.05.01 Concrete

Concrete shall be according to OPSS 1350, with a minimum specified 28-Day compressive strength of 32 MPa, Class C-2 Exposure.

353.05.02 Catch Basin Frames and Grates

Catch basin frames and grates shall be according to OPSS 1850.

353.05.03 Joint Materials

Expansion joint fillers shall be according to OPSS 1308 for types A or B except that granulated cork fillers shall not be accepted.

Hot rubberized asphalt joint sealing compound shall be according to OPSS 1212.

353.05.04 Curing Compound

Curing compound shall be according to OPSS 1315.

353.05.05 Forms

Forms shall be according to OPSS 919.

353.05.06 Steel Reinforcement

Steel reinforcement shall be according to OPSS 1440.

353.07 CONSTRUCTION

353.07.01 General

The Construction section applies equally to concrete curb and gutter, concrete spillways, and concrete gutter outlets.

353.07.02 Foundation and Backfill

Excavation and embankment construction shall be according to OPSS 206.

Granular base and granular backfill construction shall be according to OPSS 314.

353.07.03 Compaction

Compaction shall be according to OPSS 501.

353.07.04 Steel Reinforcement

Placement of steel reinforcement shall be according to OPSS 905.

353.07.05 Formwork

Formwork shall be according to OPSS 919 and shall be set true to the lines and grades specified in the Contract Documents and in direct contact with the subgrade or granular course.

353.07.06 Slipform

Slipform paving equipment is acceptable for use provided the slipform product meets the specified cross-sectional requirements.

353.07.07 Joints

When concrete curb and gutter is constructed adjacent to concrete pavement, the transverse joint spacing of the curb and gutter shall coincide with that of the concrete pavement. When concrete curb and gutter is constructed adjacent to asphalt pavement, transverse joints shall have a uniform spacing not exceeding 5 m. In addition to the foregoing, joints shall be constructed between the curb structure, including catch basin frames, setbacks, and gutter outlets.

Joints, including those between curb and gutter systems and any abutting sidewalk, catch basin frames, setbacks, gutter outlets, or any structure, shall be formed with 12 mm thick panels of joint filler except as follows:

a) Contraction joints in extruded curb and gutter and in formed curb and gutter shall be saw cut.

b) Longitudinal joints, as shown in the Contract Documents, shall be sawn between a curb and gutter system and concrete pavement and shall be according to OPSS 350, when the curb and gutter system is placed adjacent to the concrete pavement. The joint shall be sealed with liquid joint sealer and shall be according to OPSS 350.

Joint filler panels shall be set in a vertical position and, if for transverse joints, shall be set normal to the inside edge of the structure.

Panels shall be precut from a single piece of joint filler to the shape of the curb and gutter cross-section as shown in the Contract Documents, but so as to provide a 6 mm recess on the exposed surfaces. Cutting and tolerances shall be according to OPSS 1308.

Expansion joint material shall be set in place before concrete placement begins and shall be supported by removable forms.

All concrete immediately above the filler material shall be carefully removed to form a 6 mm deep, 12 mm wide recess then finishing both edges of each joint to 5 mm radius with a suitable short edging tool.

Contraction joints shall be formed within a sufficient time of placing of the curb and gutter to prevent uncontrolled cracking. The width of the joint shall be 3 to 5 mm and a depth of one quarter of the thickness of the concrete curb and concrete curb and gutter.

353.07.08 Concrete

353.07.08.01 Placement of Concrete

Concrete shall not be placed until the base course, on which the concrete is to be placed, and the forms or stringline have been inspected by the Contract Administrator.

Before placing concrete, the subgrade immediately ahead of the concrete placing shall be wetted by means of a uniform spray of water sufficient to wet the subgrade thoroughly without leaving standing water.

Concrete shall be placed and consolidated to meet the requirements of CSA A23.1.

Concrete shall be placed continuously. If placement of concrete is interrupted, recommencement of the placement operation shall be against a vertical formed joint. A 12 mm bituminous fibre joint filler shall be placed at the point of interruption before recommencing placement of concrete. Cold joints shall not be permitted.

The concrete shall be thoroughly consolidated against all formwork and all entrapped air shall be eliminated.

353.07.08.02 Concrete Finishing

The concrete on the upper surfaces shall be floated to a smooth uniform finish of the required cross-section, free of open texturing, plucked aggregate, and local projections. Only magnesium or aluminum trowels shall be used for hand finishing.

Care shall be taken to avoid over finishing or working more mortar to the surface than is actually required. Back edges shall be rounded by use of a 5 mm radius edging tool. Neat cement shall not be used as a drier to facilitate finishing.

Any honeycombed areas occurring along the formed surfaces shall be filled with mortar composed of one part Portland cement and two parts sand with 12% of entrained air.

353.07.08.03 Concrete Curing

Concrete curing shall be according to OPSS 904.

353.07.08.04 Concrete Tolerances

The exposed surfaces of the finished concrete shall be such that, when tested with a 3 m long straight edge placed anywhere along the surface parallel to the edge of curb face, there shall be no deviation greater than 3 mm between the bottom of the straight edge and the surface of the concrete nor shall there be any deviation from alignment in excess of 3 mm.

353.07.09 Cold Weather Concreting

Protection of concrete shall be according to OPSS 904. The components of the curb and gutter system shall be considered as slabs on the ground.

353.07.10 Hot Weather Concreting

Where the air temperature exceeds 28 ^{o}C and the concrete temperature exceeds 25 ^{o}C, the discharge time shall be reduced to a maximum of one hour after the introduction of mixing water. Concrete shall not be placed in air temperatures exceeding 35 ^{o}C.

353.07.11 Protection of Sidewalk

Vehicular traffic, including construction equipment, shall be restricted from crossing the sidewalk after the concrete has been placed for a minimum period of three days or until the concrete has attained 20MPa.

353.07.12 Catch Basin and Maintenance Hole Frames and Grates

Catch basin and maintenance hole frames and grates which lie within the flow lines of the curb and gutter system shall be installed as part of the construction of the various components making up the curb and gutter system. Frames shall be set to their final elevation according to OPSS 407. The exposed surfaces of the mortar bed shall be left in a smooth condition, free of depressions, and projections. All remaining formwork shall be removed.

353.07.13 Identification Stamp

At the request of the Contract Administrator, each end of the work and every 20 m shall be legibly marked with an approved stamp. The mark shall be located in the centre of an exposed face of the curb and gutter systems. The mark shall bear the Contractor's name and the year of construction.

353.07.14 Field Sampling and Testing of Concrete

Field sampling and testing of concrete shall be according to OPSS 1350.

353.07.15 Management of Excess Material

Management of excess material shall be as specified in the Contract Documents.

353.09 MEASUREMENT FOR PAYMENT

353.09.01 Actual Measurement

353.09.01.01 Concrete Curb and Gutter

Measurement of concrete curb and gutter shall be by length in metres along the flow line of the gutter whether straight or curved, without separation into types. Such measurements shall include the space occupied by setbacks, gutter outlets, and frames with grates.

353.09.01.02 Concrete Spillways

Measurement of concrete spillways shall be by length in metres along the flow line from the end of the gutter outlet to the spillway termination.

353.09.01.03 Concrete Gutter Outlets

For measurement purposes, a count shall be made of the number of setbacks and gutter outlets installed without separation into types.

353.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clause under Actual Measurement.

353.10 BASIS OF PAYMENT

353.10.01 Concrete Curb and Gutter - Item
Concrete Spillways - Item
Concrete Gutter Outlets - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

When roadbed granular material is measured in square metres, the Contract price for the above item shall be full compensation for all labour, Equipment, and Material for the material directly below or behind the concrete curb and gutter system.

There shall be no separate payment of concrete used for fillets in bullnoses.

353.10.02 Hot Mix Asphalt

Hot mix asphalt designated for constructing bullnose fillets shall be paid for at the Contract price for the appropriate Hot Mix Asphalt tender item.

353.10.03 Granular

Granular materials required for the work shall be paid for at the Contract price for the appropriate granular tender item.

353.10.04 Excavation

Excavation required to set the various components to the required line and grade shall be considered as part of the work of installing the curb and gutter system. When such excavation overlaps excavation required for any other work under the Contract, then payment shall be made in accordance with the

specification for such other work as though no excavation were required for curb and gutter construction.

353.10.05 Steel Reinforcement

Costs for supplying and placing steel reinforcement are deemed to be included in the items for concrete curb and gutter systems.

Appendix 353-A, Commentary for OPSS.MUNI 353, November 2021
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Certification such as Municipal Exterior Flatwork Certification, or ACI Flatwork Certification, or approved equivalent. Where ACI Flatwork Certification means the certification issued by the American Concrete Institute, after demonstrating knowledge and the ability to place, consolidate, finish, edge, joint, cure and protect concrete flatwork. And where Municipal Exterior Flatwork Certification means the certification issued by Ready Mixed Concrete Association of Ontario (RMCAO), after demonstrating knowledge to place, consolidate, finish, edge, joint, cure and protect concrete flatwork. (353.04.01)

- Line and grade for curb and gutter systems. (353.07.05)

- Testing frequency. (353.07.12)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 600.010	Concrete Barrier Curb with Wide Gutter
OPSD 600.020	Concrete Semi-Mountable Curb with Wide Gutter
OPSD 600.030	Concrete Mountable Curb with Wide Gutter
OPSD 600.040	Concrete Barrier Curb with Standard Gutter
OPSD 600.060	Concrete Semi-Mountable Curb with Standard Gutter
OPSD 600.070	Concrete Barrier Curb with Standard Gutter, Two-Stage Construction
OPSD 600.080	Concrete Barrier Curb with Narrow Gutter
OPSD 600.090	Concrete Semi-Mountable Curb with Narrow Gutter
OPSD 600.100	Concrete Mountable Curb with Narrow Gutter
OPSD 600.110	Concrete Barrier Curb
OPSD 604.010	90° Concrete Outlet for Concrete Curb with Gutter
OPSD 605.010	45° Concrete Outlet for Concrete Curb with Gutter
OPSD 605.030	45° Concrete Outlet for Concrete Curb with Gutter at End of Run
OPSD 606.010	600 mm Radius Barrier Bullnose
OPSD 606.020	600 mm Radius Mountable Bullnose
OPSD 606.030	800 mm Radius Mountable Bullnose, Curb with Gutter Twin Inlet
OPSD 607.010	Over 600 mm Radius Mountable Bullnose
OPSD 607.020	Over 600 mm Radius Barrier Bullnose
OPSD 608.010	Method of Termination for Concrete Curb with Gutter

CONSTRUCTION SPECIFICATION FOR THE INSTALLATION OF INTERLOCKING CONCRETE PAVERS

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355.10 **BASIS OF PAYMENT**

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335-A **Commentary**

355.01 SCOPE

This specification covers the requirements for the installation of interlocking concrete pavers for pavements, sidewalks, boulevards, and medians. The work includes the grading, placement of subsurface drainage, subbase, base, bedding sand, joint sand, edge restraints, and interlocking concrete pavers. This specification applies to both manual and mechanical installations.

355.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be as specified in the Contract Documents.

355.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

355.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 206	Grading
OPSS 310	Hot Mix Asphalt
OPSS 314	Untreated Granular, Subbase, Base, Surface Shoulder, and Stockpiling
OPSS 350	Concrete Pavement and Concrete Base
OPSS 405	Pipe Subdrains
OPSS 501	Compacting

Ontario Provincial Standard Specifications, Material

OPSS 1002	Aggregates - Concrete
OPSS 1004	Aggregates - Miscellaneous
OPSS 1010	Aggregates - Base, Subbase, Select Subgrade, and Backfill Material
OPSS 1860	Geotextiles

CSA Standards

A231.2:19	Precast Concrete Pavers

355.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Bedding Sand means a layer of uncompacted sand that is screeded smooth prior to placement of the concrete pavers.

Concrete Paver means a precast concrete paving product.

Edge Restraint means a curb, edging, building, or other appurtenance that is intended to confine the bedding sand and concrete pavers so that the concrete pavers do not spread and lose interlock.

Joint Sand means a fine, dry sand used to fill the joint space and interlock the concrete pavers.

Manufactured Sand means sand produced by the crushing and further processing (i.e., washing, grading, classifying of quarried rock, boulders, cobbles, or gravel) from which the natural fine aggregate has been removed.

355.04 DESIGN AND SUBMISSION REQUIREMENTS

355.04.01 Submission Requirements

Laboratory test results indicating compliance to material requirements and a full-size sample of each type of concrete paver shall be submitted to the Contract Administrator at least 10 Business Days prior to commencement of paver installation.

355.05 MATERIALS

355.05.01 Granular Subbase

The granular subbase material shall be Granular B according to OPSS 1010.

355.05.02 Granular Base

The granular base material shall be Granular A according to OPSS 1010.

355.05.03 Bedding and Joint Sand

Bedding sand shall meet the requirements of concrete sand according to OPSS 1002. For applications under vehicular traffic, manufactured sand shall be used. Limestone screenings or stone dust shall not be used.

Joint sand shall be dry and meet the gradation requirements of mortar sand according to OPSS 1004 and the physical requirements according to OPSS 1002.

Use of polymeric joint sand shall be as specified in the Contract Documents.

The bedding and joint sand shall be free of organics and deleterious soluble salts or other contaminants.

355.05.04 Concrete Pavers

Concrete pavers shall be according to CSA-A231.2. Concrete paver size, shape, colour, thickness, and texture shall be as specified in the Contract Documents.

Mechanically installed concrete pavers shall have integral spacer nibs on all vertical faces to control joint spacing.

355.05.05 Edge Restraints

Edge restraints shall be as specified in the Contact Documents.

355.05.06 Geotextile

Geotextile shall be non-woven, Class 1, according to OPSS 1860 with an FOS of 60 to 120 μm.

355.06 EQUIPMENT

355.06.01 Compaction

Concrete pavers shall be set into the bedding sand using a high frequency, low amplitude, mechanical flatplate vibratory compactor having a plate area sufficient to cover a minimum of 12 concrete pavers. The compactor shall transmit an effective force of not less than 75 kN per square metre of plate area. The frequency of vibration shall be within the range of 75 to 100Hz.

Pneumatic-tired roller shall have a gross weight of 10 tonnes.

355.07 CONSTRUCTION

355.07.01 Subgrade Preparation

Preparation of the subgrade shall be according to OPSS 206.

355.07.02 Subbase and Base

When the interlocking concrete pavers are being placed on:

a) Granular base, the base and subbase layers shall be constructed according to OPSS 314.

b) Concrete base, the base layer shall be constructed according to OPSS 350.

c) Asphalt base, the base layer shall be constructed according to OPSS 310.

The depth shall be as specified in the Contract Documents.

Both granular subbase and base shall be compacted according to OPSS 501.

355.07.03 Subsurface Drainage

Subsurface drainage shall be as specified in the Contract Documents. Subdrains shall be constructed according to OPSS 405.

Geotextile shall be installed at all drain locations between the bedding sand and the drain surface extending 100 mm beyond the drain in all directions.

355.07.04 Bedding Sand

355.07.04.01 Placement

The bedding sand shall be placed loose, in a uniform layer with sufficient depth to achieve the final compacted thickness of 20 to 30 mm.

355.07.04.02 Screeding

The bedding sand shall be screeded in a loose condition and protected against compaction prior to placement of the concrete pavers.

355.07.05 Edge Restraint

Edge restraints shall be provided along the perimeter of all concrete paver installations.

355.07.06 Laying Pattern

Concrete pavers shall be installed in the pattern as specified in the Contract Documents. Cutting of the concrete pavers, the use of infill concrete, and discontinuities in pattern shall only be allowed along the outer pavement boundaries and adjacent to drains, maintenance holes, edge restraints, and other appurtenances. Where partial concrete pavers are required, they shall be sawcut. No less than one-third of a concrete paver shall be used in pavement subjected to vehicular traffic.

355.07.07 Placement

Concrete pavers shall be placed uniformly to achieve normal joint spacing of 2 to 5 mm between adjacent concrete pavers and such that all joints are aligned.

Concrete pavers shall only be placed on loose moist bedding sand.

355.07.08 Compaction

355.07.08.01 Initial Compaction

After placement, compactive effort shall be applied to the concrete pavers to achieve compaction of the bedding sand and to achieve proper grade. At least three passes of a plate compactor shall be made across the surface of the concrete pavers.

355.07.08.02 Joint Sand Compaction

After initial compaction, dry joint sand shall be uniformly spread over the concrete pavers and swept to fill in the joints. At least two passes of a plate compactor shall be applied to the surface while simultaneously sweeping the sand into the joints. Joints shall be completely filled at the completion of compaction. Excess sand shall then be removed from the pavement surface by sweeping.

355.07.08.03 Final Compaction

On pavements subject to vehicular traffic, final compaction shall be achieved by not less than 10 passes of a pneumatic-tired roller.

355.07.09 Surface Tolerance

The surface of the concrete pavers is to be such that when tested with a 3 m long straightedge placed in any direction on the surface, except across the crown or drainage gutters, the gap between the bottom of the straightedge and the surface of the concrete pavers shall not be greater than 3 mm for vehicular applications and not greater than 6 mm for other applications.

355.07.10 Removal of Unacceptable Concrete Pavers

All loose concrete pavers and concrete pavers that do not meet the surface tolerance shall be removed and reinstalled.

All damaged concrete pavers shall be removed and replaced.

355.07.11 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

355.09 MEASUREMENT FOR PAYMENT

355.09.01 Actual Measurement

355.09.01.01 Interlocking Concrete Pavers

Measurement shall be made for the area of concrete pavers placed in square metres without deduction for maintenance hole covers, Utility poles, and other appurtenances.

355.09.02 Plan Quantity Payment

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clause under Actual Measurement.

355.10 BASIS OF PAYMENT

355.10.01 Interlocking Concrete Pavers-Item

Payment at the Contract price for the above item shall be full compensation for all labour, Equipment, and Material to do the work.

Removal and reinstallation of loose concrete pavers or concrete pavers not meeting surface tolerances shall be at no extra cost to the Owner.

Removal and replacement of damaged concrete pavers shall be at no additional cost to the Owner.

Appendix 355-A, November 2020
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Polymeric sand may be used as an alternative to joint sand. (355.05.03)

- Size, shape, colour, thickness, and texture of the concrete pavers. (355.05.04)

- Type of edge restraint. (355.05.05)

- Type and depth of subbase and base required for traffic loads and soil conditions. (355.07.02)

- Subsurface drainage requirements and adequate drainage of the bedding sand at low points. (355.07.03)

- Pattern of concrete pavers. (355.07.06)

Application should be restricted to roads with traffic speeds of 70 km/h or less.

A herringbone pattern at 45° to the vehicular traffic is recommended for roadway pavements.

Where surface sealers are specified, a reduction in frictional resistance may result.

Related technical publications for designers' use are available from the Interlocking Concrete Pavement Institute (ICPI) at www.icpi.org.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 561.010	Interlocking Concrete Pavers on Granular Base
OPSD 561.020	Interlocking Concrete Pavers on Concrete or Asphalt Base
OPSD 561.030	Interlocking Concrete Pavers for Retrofit Crosswalk Installation

CONSTRUCTION SPECIFICATION FOR PERVIOUS CONCRETE PAVEMENT FOR LOW-VOLUME TRAFFIC APPLICATIONS

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356-A **Commentary**

356.01 SCOPE

This specification covers the requirements for the construction of pervious concrete pavement for low-volume traffic applications. This specification includes requirements for a trial section and special equipment and testing requirements.

356.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be as specified in the Contract Documents.

356.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

356.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 919 Formwork and Falsework

Ontario Provincial Standard Specifications, Material

OPSS 1002 Aggregates - Concrete
OPSS 1004 Aggregates - Miscellaneous
OPSS 1305 Moisture Vapour Barriers
OPSS 1308 Joint Filler in Concrete
OPSS 1350 Concrete - Materials and Production

Ontario Ministry of Transportation Publications

MTO Laboratory Testing Manual:
LS-443 Method of Test for the Determination of the Void Content of Pervious Concrete Pavement Cores

CSA Standards

A23.2-3C Making and Curing Concrete Compression and Flexural Test Specimens *
A23.2-9C Compressive Strength of Cylindrical Concrete Specimens *
A23.2-14C Obtaining and Testing Drilled Cores for Compressive Strength Testing *
* [Part of A23.1-09/A23.2-09 - Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete]

ASTM International

C 1116/C 1116M-09	Standard Specification for Fibre Reinforced Concrete
C 1688/C 1688M-08	Standard Test Method for Density and Void Content of Freshly Mixed Pervious Concrete

356.03 DEFINITIONS

For the purposes of this specification, the following definitions apply:

Cold Weather means those conditions when the air temperature is at or below 10 °C. It is also considered to exist when the air temperature is at or is likely to fall below 10 °C within 96 hours after pervious concrete placement. Temperature refers to shade temperature.

Construction Joint means the surface where two successive placements of pervious concrete meet or where new pervious concrete is placed against existing concrete across which it is desirable to achieve bond between the two concrete placements.

Control Joint means a joint that is created by scoring or sawcutting to prevent uncontrolled cracking due to drying or thermal shrinkage.

Isolation Joint means a joint that allows relative movement to take place between adjoining parts of a structure or pavement to prevent damage to the concrete.

Pervious Concrete Pavement means a rigid pavement structure that allows water flow into and through the pavement structure.

Surface Ravelling means the loss of coarse aggregate from the surface of the pervious concrete pavement.

356.04 DESIGN AND SUBMISSION REQUIREMENTS

356.04.01 Submission Requirements

356.04.01.01 Mix Design

The concrete mix design shall be submitted to the Contract Administrator according to OPSS 1350, with the following exceptions:

a) The mix design shall be submitted before the trial section is placed.

b) The air void system parameters of the hardened concrete shall not be required.

c) Pervious concrete mix shall meet the material requirements of this specification.

d) Strength results are not required with the mix design submission.

e) Mix design supporting documentation shall include a certificate from the National Ready Mixed Concrete Association (NRMCA) verifying that at least one member of the Contractor's team, who is responsible for the supervision of the placement of the pervious concrete, is certified by the NRMCA Pervious Concrete Contractor Certification program.

356.04.01.02 Trial Section

Three Business Days prior to the start of the trial section, the following information shall be submitted to the Contract Administrator:

a) Date, time, and location of the trial section.

b) Method and equipment to be used to place and compact the pervious concrete pavement.

c) Name of the NRMCA certified staff to be present and responsible for supervision of the placement.

356.05 MATERIALS

356.05.01 Forms

Forms, if used, shall be according to OPSS 919. Form materials shall extend the full depth of the pavement. Forms shall be of sufficient strength and stability to support mechanical equipment without deformation. Spacers, if used, shall be made of wood and shall be the same width as the formwork.

356.05.02 Isolation Joint Material

Isolation joint material shall be according to OPSS 1308.

356.05.03 Moisture Vapour Barrier

Moisture vapour barrier shall be according to OPSS 1305.

356.05.04 Pervious Concrete

The pervious concrete shall have a minimum 28-Day core compressive strength of 15 MPa, when tested according to CSA A23.2-9C and this specification.

Pervious concrete shall be according to OPSS 1350 with the following exceptions:

a) Pervious concrete plastic density shall be measured according to ASTM C 1688 and shall be within $\pm$ 80 kg/m^3 of the plastic density of the trial section.

b) The pervious concrete in the hardened state shall have a void content between 15 to 25%, when tested according to LS-443.

c) Coarse and fine aggregate are not required to meet the gradation requirements of OPSS 1002.

d) A viscosity modifying admixture (VMA) may be used. The trial section shall be used to observe and test the compatibility of the VMA with other admixtures and cementing materials.

e) Use of water reducer is not required.

f) Superplasticizer may be used.

g) Slump requirements shall not apply.

h) The testing requirements of OPSS 1350 for plastic and hardened air void testing shall not apply. The paste shall be adequately air entrained to provide freeze thaw resistance, with air entraining admixture dosage based on the dosage level typically used for mix designs with similar water to cement ratio.

i) The coarse aggregate shall have a maximum nominal aggregate size less than or equal to 13.2 mm.

j) Type III synthetic fibres according to ASTM C 1116 may be used. If used, synthetic fibres shall be added at the plant.

k) In addition, for municipal-oriented Contracts, the Material Sampling and Testing subsection requirements shall not apply, with the exception of the testing of water, admixtures, and cementing materials.

356.06 EQUIPMENT

356.06.01 General

Equipment made of aluminium material shall not come in contact with the plastic pervious concrete.

356.06.02 Placing Equipment

Equipment used for placing the pervious concrete shall be one of the following:

a) A slipform paver.

b) A laser screed.

c) A razorback steel truss screed, with vibratory or Clary screed.

d) A vibratory steel screed, or steel roller screed with integral internal vibration.

356.06.03 Compaction Equipment

356.06.03.01 Roller Compaction Equipment

Rolling compaction shall be achieved using a steel pipe roller that spans the width of the section to be placed and exerts sufficient pressure to provide the necessary compaction.

356.06.03.02 Hand Tampers

Hand compaction equipment shall have a maximum width of 300 mm.

356.06.04 Edging Tools

Edging tools shall have a 6 mm radius.

356.06.05 Straight Edges

Straight edges shall be 3 m in length and made of metal.

356.07 CONSTRUCTION

356.07.01 General

The Contract Administrator shall be notified in writing of the intent to place the pervious concrete pavement 3 Business Days prior to the start of the placing operation.

356.07.02 Operational Constraints

Placement of pervious concrete during cold weather is not permitted.

Pervious concrete shall not be placed in the rain. All necessary precautions shall be taken to protect placed plastic pervious concrete from rainfall.

Pervious concrete shall not be placed when the ambient air temperature is above 28 °C or likely to rise above 28 °C, throughout the duration of the placing operation.

Pervious concrete shall not be placed against any material that is at a temperature above 35 °C, or against any material that is at a temperature below 5 °C.

Traffic, other than foot traffic, shall not be permitted on the pervious concrete pavement until the pervious concrete has attained a core compressive strength of 15 MPa.

The pervious concrete pavement shall be protected from damage to its surface when steel-tracked equipment is used.

Construction equipment and trucks heavier than 20,000 kg shall not be permitted on the pervious concrete pavement at any time.

When a drainage system is part of the design, it shall be operational prior to the placement of the pervious concrete.

356.07.03 Trial Section

The trial section shall be constructed, in the presence of the Contract Administrator, to demonstrate the Contractor's ability to successfully produce, place, and finish pervious concrete pavement. The trial section shall be placed a minimum of 4 weeks prior to pervious concrete being placed in the work. The Contract Administrator shall be notified of the trial placement date 3 Business Days in advance.

The trial slab 10 metres long shall be constructed, at the paving thickness specified in the Contract Documents. The width of the trial slab shall be the width of the widest section that is intended to be placed at one time. The location of the trial section shall be proposed to the Contract Administrator for approval. To simulate the effect of travel time, the trial section location shall not be farther from a ready mix plant than the job site. In the event that the trial section location is closer to the plant than the job site, the discharge from the ready mix truck shall be delayed sufficiently to match the estimated travel time.

The trial section shall be constructed with pervious concrete of the same materials and mix design; supplied by the same ready mix plant; and placed, consolidated, and cured using the materials, equipment, and personnel, including NRMCA-certified supervisors that the Contractor intends to use in the work.

All Aspects of coring and conducting tests shall be undertaken on pervious concrete pavement to determine thickness, compressive strength, and void content.

Plastic density and void content shall be determined according to ASTM C 1688 and the test results shall be submitted to the Contract Administrator.

Thickness, compressive strength, and hardened density and void content, shall be determined by dividing the trial section into 6 sections of equal size and shape, removing one 100 mm diameter full-depth core from each of the 6 sections according to CSA A23.2-14C, and testing the cores as follows:

a) All cores shall be tested for thickness according to the Acceptance of Thickness subsection.

b) Three cores shall be tested for hardened density and void content according to LS-443.

c) The remaining three cores shall be tested for 28-Day compressive strength according to CSA A23.2-9C and this specification.

Test results shall be submitted to the Contract Administrator to determine acceptability of the trial section according to the Table 1. Once acceptability of the trial section is confirmed in writing by the Contract Administrator, placement of pervious concrete may commence. If the trial section is not accepted, another trial section shall be constructed. Unacceptable trial sections in the work shall be removed.

Placement in the work can proceed early if all requirements are met, including meeting the specified core compressive strength.

356.07.04 Placing

A person certified according to the NRMCA Pervious Concrete Contractor Certification program shall be responsible for the supervision of the placement of the pervious concrete.

Before placing pervious concrete on granular base, the granular immediately ahead of the pervious concrete paving operation shall be wetted down thoroughly without leaving standing water.

The granular base material shall not be disturbed or displaced by any equipment used for the placing operations.

During placement, pervious concrete shall be uniform in consistency with no visible signs of segregation and free of lumps.

Placement shall be continuous.

Pervious concrete shall be deposited within 1.5 m of its final position.

Sufficient material shall be in front of the placement equipment to ensure there are no low spots.

Discharge of individual loads of pervious concrete shall be completed within 90 minutes of the introduction of mix water to the cement. If there is an interruption in placement, the pervious concrete shall be covered with a moisture vapour barrier. When an interruption of more than 20 minutes occurs, a construction joint shall be made.

356.07.05 Compaction

Following placement and strike-off, pervious concrete shall be compacted. This compaction process may be done with or without the use of spacers. Spacers, if used, shall be removed after strike-off and before compaction.

The concrete shall be compacted to the level of the top of the forms or to the final elevation, depending on the equipment used for placement, using a steel roller. Longitudinal rolling shall be required, followed immediately by rolling in the transverse direction, if required to remove surface indentation or other surface irregularities. Care shall be taken during compaction that sufficient compactive force is applied, without excessively working or consolidating the concrete surface such that the void structure of the pervious concrete is closed.

Hand tampers shall be used to compact the concrete along the slab edges immediately adjacent to the forms. After placement and compaction, no further finishing shall be performed on the concrete and no material shall be applied to the concrete.

Finishing and edging shall begin as soon as the pervious concrete is discharged from the truck.

356.07.06 Joints

Control joints shall not be required.

A construction joint should be installed at the end of the day's production or when an interruption of more than 20 minutes occurs in the concrete paving operation.

Isolation joints shall be used when abutting appurtenances and fixed vertical structures, including light pole bases and building foundations. Isolation joint material shall be according to this specification.

Edging and additional compaction with hand tamping tools shall be performed along all form lines and along all isolation joints and construction joints to reduce potential for ravelling under traffic.

356.07.07 Curing

A moisture vapour barrier shall be placed on the surface of the pervious concrete immediately after compacting the pervious concrete surface, within 2 to 4 m of the compacting operation. Air flow in the space between the moisture vapour barrier and the concrete surface shall be prevented. The moisture vapour barrier strips shall overlap 150 mm and shall be held in place at the edges and laps to prevent displacement, without marring the surface of the concrete. Curing shall continue for a minimum period of 7 Days.

356.07.08 Surface Appearance

The finished pervious concrete pavement surface shall have a uniform open texture and shall, over a 100 m^2 section, be free of:

a) a single surface appearance deficiency exceeding 1 m^2, or

b) the combined area of multiple surface appearance deficiencies exceeding 2 m^2.

Surface appearance deficiencies include, but are not limited to, the following:

a) Tears.

b) Plastic shrinkage cracking.

c) Streaking.

d) Accumulation of paste.

e) Contamination by tracking, spilling, or placing of mud or other contaminants onto the pavement.

f) Presence of closed surface.

Surface appearance shall be assessed by a visual survey.

356.07.09 Surface Tolerance

Except across the crown or drainage gutters, the surface of the pervious concrete pavement shall be such that when tested with a 3 m long straight edge placed in any location and direction, including the edge of pavement and joints, there shall not be a gap greater than 10 mm between the bottom of the straight edge and the surface profile of the pervious concrete pavement.

356.07.10 Surface Ravelling

The surface of the pervious concrete pavement shall not exhibit any surface ravelling based on a visual review.

356.07.11 Sampling and Testing

356.07.11.01 Plastic Pervious Concrete

Carry out all aspects of sampling and testing of the plastic pervious concrete.

Quality control testing shall consist of plastic density and void content testing. Plastic density and void content shall be measured according to ASTM C 1688. The plastic density shall be within 80 kg/m^3 of the plastic density of the trial section. Quality control testing shall be performed on each load of pervious concrete.

356.07.11.02 Hardened Pervious Concrete

356.07.11.02.01 General

After a minimum of 8 Days and a maximum of 10 Days, two sets of three 100 mm diameter cores per sublot shall be taken. The locations for the two sets of cores shall be randomly selected by the Contract Administrator. Each set shall be taken within a 1 m^2 area in each location. No core shall be taken within 250 mm of any joint or edge of slab. Cores shall be drilled through the complete depth of pervious concrete pavement perpendicular to the surface of the slab. Cores shall be drilled according CSA A23.2-14C.

The cores shall be delivered to the quality assurance (QA) laboratory designated by the Owner in the Contract Documents for testing. The cores shall be stored at a temperature of 23 °C $\pm$ 2 °C in a moist condition, according to the laboratory curing requirements of CSA A23.2-3C, until time of testing.

The cores shall be tested for:

a) Thickness according to the Acceptance of Thickness clause.

b) Hardened void content and density according to LS-443.

c) Compressive strength according to CSA A23.2-9C except that the load shall be applied until complete failure of the specimen.

356.07.11.02.02 Lot Size

A lot shall consist of the total quantity of pervious concrete pavement of the same specified thickness on the Contract. Each lot shall be divided into 500 m^2 sublots or a minimum of three sublots. If the quantity of pervious concrete placed on one day is less than 500 m^2, it shall be considered a sublot.

356.07.11.02.03 Filling of Core Holes

Each core hole shall be filled immediately after coring with pervious concrete. When pervious concrete is not available, 13.2 mm clear stone may be used to meet the requirements of OPSS 1004 to fill the core hole to 35 mm from the concrete pavement surface and cover with hydraulic cement based concrete patching material. The patching material shall be mixed, handled, and cured according to the manufacturer's instructions. Immediately before filling, the inside surface of each core shall be cleaned by nylon brushing. The patch shall be finished flush with the surface of the surrounding pervious concrete pavement. All excess material shall be removed from the surface of the pervious concrete pavement.

356.07.11.02.04 Identification of Cores

Each core shall be legibly labelled immediately after its removal from the slab. The core shall be placed into a sample bag and sealed with a tag provided by the Contract Administrator. The core identification numbers shall be specified by the Contract Administrator.

356.07.11.02.05 Transportation of Cores

Transport cores in a safe manner that avoids damage to the cores. The cores shall be delivered to the laboratory designated by the Owner. The cores shall be delivered on the same day they are obtained. The cores shall be kept at a temperature above 5 °C and protected from moisture loss during transportation.

356.07.12 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

356.08 QUALITY ASSURANCE

356.08.01 General

Acceptance shall be based on a visual inspection and QA testing of the completed work as outlined below. Pervious concrete pavement deemed unacceptable shall be repaired according to Table 2.

356.08.02 Acceptance Based on Visual Inspection

A visual inspection of the pervious concrete pavement surface shall be conducted by the Contract Administrator to determine if any of the following defects are present:

a) Surface appearance not meeting the requirements of the Surface Appearance subsection.

b) Surface tolerance not meeting the requirement of the Surface Tolerance subsection.

c) Slight, moderate, or severe surface ravelling.

   Slight surface ravelling is defined as the loss of the top layer of coarse aggregate in less than 1% of the surface area of the lot. Moderate surface ravelling is defined as the loss of the top layer of coarse aggregate in 1 to 10% of the surface area of the lot. Severe surface ravelling is defined as the loss of the top layer of coarse aggregate in more than 10% of the surface area of the lot or the loss of more than one layer of coarse aggregate, exceeding a depth of 26 mm, in any area of the lot.

Visual inspection for ravelling shall be carried out prior to opening to traffic, at the completion of the Contract and at the Warranty Period inspection.

Pervious concrete pavement not meeting surface appearance or surface tolerance requirements shall be deemed unacceptable.

Pervious concrete pavement sublots with slight ravelling shall be accepted. Pervious concrete pavement sublots with moderate surface ravelling or severe surface ravelling shall be deemed unacceptable.

356.08.03 Acceptance for Thickness

All cores shall be measured for thickness. Untrimmed hardened core samples shall be used to determine placement thickness. For each core, 4 length measurements shall be taken, rounded to the nearest millimetre. The measurements shall be taken at the ends of perpendicular diameters. The thickness of each sublot shall be based on the average length of all cores within the sublot.

Sublots with an average core thickness of more than 6 mm less than the specified thickness or with an individual core thickness of more than 13 mm less than the specified thickness shall be deemed unacceptable.

356.08.04 Acceptance for Void Content and Density

For each sublot, one set of three 100 mm diameter cores shall be measured for void content and density according to LS-443.

Sublots with an average void content less than 15% or more than 25% and any individual void content in excess of 35% shall be deemed unacceptable.

356.08.05 Acceptance for Core Compressive Strength

For each sublot, the second set of three 100 mm diameter cores shall be measured for core compressive strength according to CSA A23.2-9C and this specification.

Sublots with an average core compressive strength less than 15 MPa at 28 Days or an individual core compressive strength less than 11 MPa at 28 Days shall be deemed unacceptable.

356.09 MEASUREMENT FOR PAYMENT

356.09.01 Actual Measurement

356.09.01.01 Pervious Concrete Pavement

Measurement of pervious concrete pavement shall be by surface area in square metres to the nearest 0.1 m^2 of pervious concrete pavement placed.

356.10 BASIS OF PAYMENT

356.10.01 Pervious Concrete Pavement - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work, subject to the payment adjustment specified in Table 2.

The following shall be carried out at no extra cost to the Owner:

a) Additional trial sections.

b) Repairs to pervious concrete pavement deemed unacceptable.

TABLE 1
Pervious Concrete Pavement Trial Section Acceptance Requirements

Criteria	Acceptance Requirement
Surface Appearance, m^2 per 100 m^2	No single irregularity $\geq$ 1
	No combined multiple irregularities $\geq$ 2
Surface Tolerance, mm gap	$\leq$ 10
Surface Ravelling Severity (Note 1)	None or Slight
Thickness, mm less than specified thickness	Single core not more than 13
	Average of 3 cores not more than 6
Thickness, mm more than specified thickness	Single core < 20
28-Day Core Compressive Strength, MPa	$\geq$ 15
Void Content, %	20 $\pm$ 5

Note:

1. Surface ravelling severity definitions according to the Acceptance Based on Visual Inspection subsection.

TABLE 2
Repairs to Unacceptable Pervious Concrete Pavement

Criteria	Repair Requirement	Repair
Surface Tolerance, mm gap	> 10	Submit a proposal for remedial work to the Contract Administrator for approval or remove pervious concrete pavement to full depth as directed by the Contract Administrator and replace with acceptable pervious concrete pavement.
Surface Ravelling Severity (Note 1)	Slight	None.
	Moderate	Sublot represented shall be assessed a payment reduction of 10%.
	Severe	Remove pervious concrete pavement to full depth in the sublot represented and replace with acceptable pervious concrete.
Surface Appearance, m^2 per 100 m^2	Single irregularity ≥ 1 Combined multiple irregularities ≥ 2	Remove pervious concrete pavement to full depth in the sublot represented and replace with acceptable pervious concrete.
Thickness, mm less than specified thickness	Single core > 13 Sublot > 6	
28-Day Core Compressive Strength, MPa	Single core < 11 Sublot < 15	
Void Content, %	Single core > 35 Sublot < 15 or > 25	

Note:

1. Surface ravelling severity definitions according to the Acceptance Based on Visual Inspection subsection.

Appendix 356-A, November 2018
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

Pervious concrete pavement is suitable for low-traffic applications, including parking lots, boulevards, and walkways.

The designer should specify the following in the Contract Documents:

- Thickness of pervious concrete pavement. (356.07.03)

- QA laboratory. (356.07.11.02.05)

Pervious concrete pavement is a part of a site-specific stormwater management system. Pervious concrete pavement can reduce the impact of stormwater by reducing runoff volumes and decreasing and delaying peak flows.

The pavement structure design should follow the guidelines of the StreetPave software distributed by the American Concrete Pavement Association or equivalent.

The designer should be aware pervious concrete pavement requires enhanced maintenance processes to ensure long-term performance.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

CONSTRUCTION SPECIFICATION FOR FULL DEPTH REPAIR OF CONCRETE PAVEMENT OR CONCRETE BASE

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360-A **Commentary**

360.01 SCOPE

This specification describes the requirements for full depth repair of concrete pavement or concrete base including saw cutting; removal of pavement; installation of epoxy coated tie bars, dowel bars and load transfer devices; forming joints; and placing, texturing, and curing of the concrete.

360.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be as specified in the Contract Documents.

360.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

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The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

360.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 350 Concrete Pavement and Concrete Base
OPSS 904 Concrete Structures

360.03 DEFINITIONS

For the purpose of this specification the following definitions shall apply:

Dowel Bars means any reference to dowel bars including dowel bar cap.

Staged Repair means where an area cannot be repaired completely due to traffic or construction sequence requirements, the repair shall be completed in separate stages. Each stage shall be a minimum of one lane in width and 2 m in length.

360.05 MATERIALS

360.05.01 Epoxy Resins

Epoxy resins shall be as specified in the Contract Documents.

360.05.02 Concrete

Concrete shall be according to OPSS 350.

360.06 EQUIPMENT

360.06.01 General

Equipment for full depth repair of concrete pavement or concrete base shall be according to the Equipment section of OPSS 350.

360.06.02 Placing and Finishing Equipment

Equipment used for placing, consolidating, and finishing concrete shall be a self-propelled, vibratory steel screed or steel cylinder screed with integral internal vibration including automatic shut-off, levelling auger, and shall operate on fixed forms. For repair areas less than 10 m in length, the concrete may be placed with a vibratory steel screed.

360.06.03 Gang Drill

The gang drill shall consist of not less than three independently powered pneumatic drills. Drilling equipment shall be used in such a way so as not to damage the adjacent pavement.

360.07 CONSTRUCTION

360.07.01 Staged Repair

When the operation requires a staged repair, additional dowel bars shall be installed to connect the repair stages, as required.

360.07.02 Concrete Removal

The outer limits of the concrete removal shall be saw cut full depth. The concrete removal method shall ensure that the concrete to be removed is not broken in place and that the adjoining concrete and underlying base remains undisturbed. When the existing granular base is disturbed, the loosened material shall be removed, the surface compacted, and replaced with an additional depth of concrete.

360.07.03 Preparation Work

The preparation work for full depth repair of concrete pavement or concrete base shall be according to OPSS 350.

360.07.04 Joints

Joints for full depth repair of concrete pavement or concrete base shall be according to OPSS 350.

360.07.04.01 Dowel Bar and Tie Bar Placement

Gang drills shall be used to drill holes in the existing concrete for insertion of the dowel bars or tie bars. Drill holes shall be thoroughly cleaned. The dowel bars or tie bars shall be secured into the existing concrete with epoxy resin. The epoxy resin shall be injected into the back of the cleaned drill hole and the dowel or

tie bar, with grout retention disks attached, shall be inserted to ensure the bars are completely enveloped with epoxy resin.

360.07.04.02 Tie Bars

Tie bars shall be installed at all longitudinal joints as specified in the Contract Documents.

360.07.04.03 Dowel Bars at Transverse Joints

Dowel bars shall be installed at all transverse joints as specified in the Contract Documents. The tolerance for the alignment of dowel bars shall be 6 mm in the length of the dowel bar in both the vertical and horizontal planes of the pavement. When reinforcement is present, dowels may be adjusted 25 mm horizontally, and raised or lowered 10 mm, to avoid drilling the reinforcement.

360.07.04.04 Transverse Joints - Expansion

Expansion joints shall be placed when replacing existing expansion joints or as specified in the Contract Documents.

360.07.04.05 Transverse Joints - Contraction

Transverse contraction joints shall be cut or formed to match existing joints or working cracks, and skewed if required. Dowels or load transfer devices shall be installed at mid depth of the concrete slab, in a plane with the pavement surface, and parallel to the centreline of the road.

360.07.05 Concreting

360.07.05.01 General

Concreting for full depth repair of concrete pavement or concrete base shall be according to OPSS 350.

360.07.05.02 Concrete Placement

Concrete placement shall be according to OPSS 904.

Before placing concrete, it shall be demonstrated that the equipment to be used provides for proper adjustment of screeds, floats, propulsion, and control equipment.

Concrete shall be placed at or near its permanent location, at a steady rate, and in such a manner to avoid segregation of the materials. Any concrete placed beyond the outer limits of the pavement edge shall be removed immediately.

Concrete shall be placed to avoid disturbing or displacing the load transfer devices.

When an interruption in placing concrete of more than 45 minutes occurs, a transverse construction joint shall be formed.

360.07.05.03 Texturing of Surface

Texturing of the surface shall be according to OPSS 350 except that manual devices may be used to provide the required texture.

360.07.05.04 Surface Tolerance

The surface of the concrete repair shall join flush with the existing concrete pavement or concrete base.

360.07.06 Curing, Joint Sealing, Removal of Forms and Shoulders

Curing, joint sealing, and shoulders for full depth repair of concrete pavement or concrete base shall be according to OPSS 350.

360.07.07 Miscellaneous Protection

Miscellaneous protection for full depth repair of concrete pavement or concrete base shall be according to OPSS 350.

360.07.07.01 Traffic

Traffic shall be according to OPSS 350, except that for early opening determination, one set of cylinders shall be taken from every truck.

360.07.08 Sampling and Testing - Slump, Air Content and Compressive Strength

Sampling and testing for full depth repair of concrete pavement or concrete base shall be according to OPSS 350 except that the compressive strength requirement shall be based on testing of standard cylinders with a frequency of one set of two cylinders 150 X 300 mm (or one set of three cylinders 100 X 200 mm) for each fifteen cubic metre unit of concrete but not less than one set of cylinders per Day.

360.07.09 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

360.08 QUALITY ASSURANCE

360.08.01 General

Quality Assurance shall be according to OPSS 350.

360.08.02 Removal of Unacceptable Concrete

Concrete found to be unacceptable shall be removed and replaced with new material.

360.09 MEASUREMENT FOR PAYMENT

360.09.01 Actual Measurement

360.09.01.01 Full Depth Concrete Slab Repair

Measurement shall be of the surface area of the concrete repair placed in square metres.

360.09.02 Plan Quantity Measurement

360.09.02.01 Full Depth Concrete Slab Repair

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clause under Actual Measurement.

360.10 BASIS OF PAYMENT

360.10.01 Full Depth Concrete Slab Repair - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work including dowel bars, tie bars, and load transfer devices.

Where the existing granular base is disturbed, the removal of loosened material, compaction of the surface, and replacement with an additional depth of concrete shall be at no extra cost to the Owner. The removal and replacement of unacceptable concrete shall be at no extra cost to the Owner.

Appendix 360-A, November 2021
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Epoxy resins. (360.05.01)

- Tie bars. (360.07.04.02)

- Dowel Bars at Transverse Joints. (360.07.04.03)

- Transverse Joints - Expansion. (360.07.04.04)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

CONSTRUCTION SPECIFICATION FOR RUBBLIZING CONCRETE PAVEMENT AND CONCRETE BASE

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361.10 **BASIS OF PAYMENT**

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361-A **Commentary**

361.01 SCOPE

This specification covers the requirements for in-place rubblizing of concrete pavement or concrete base and compaction of the rubblized concrete.

361.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be as specified in the Contract Documents.

361.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

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361.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specification, Construction

OPSS 501 Compacting

Ontario Provincial Standard Specification, Material

OPSS 1010 Aggregates - Base, Subbase, Select Subgrade, and Backfill Material

361.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Concrete Base means a rigid pavement structure that is overlaid with asphaltic concrete on the same Contract and may include concrete shoulders.

Concrete Pavement means a rigid pavement structure with an exposed concrete surface that may include concrete shoulders.

Rubblizing means the thorough fracturing of non-reinforced or reinforced concrete slabs with or without dowels to produce an in-place material for use as a base or subbase.

361.05 MATERIAL

361.05.01 Granular A

Granular A shall be according to OPSS 1010.

361.06 EQUIPMENT

361.06.01 Rubblizing

The rubblizing equipment shall be a self-contained, self-propelled, resonant frequency pavement-breaking unit capable of producing high frequency, low amplitude blows with a minimum impact energy of 8,000 Newtons at a rate of not less than 44 impacts per second. The equipment shall be capable of rubblizing concrete pavement and concrete base in-place.

The compactor shall be a self-propelled, vibratory, single smooth steel drum grade roller with a minimum weight of 9,200 kg.

The equipment shall apply water for dust suppression, as required.

361.07 CONSTRUCTION

361.07.01 Operational Constraints

All new and existing pavement drainage systems shall be fully operational for two weeks prior to rubblizing.

Prior to rubblizing, adequate lateral support shall be provided against the existing concrete slab, either by the existing or the new granular shoulders or base.

All overlying bituminous material shall be fully removed prior to rubblizing.

Only construction traffic shall be permitted on the rubblized surface. Construction traffic shall be limited on the rubblized surface, and the compacted condition of the rubblized pavement shall be maintained prior to placing the overlying material.

The rubblizing operation shall not damage exposed road appurtenances and fixtures.

A full depth saw cut shall be made along an existing joint at all ramps and mainline pavement where rubblized concrete abuts pavement that is to remain in place. All dowels between the planned rubblizing and concrete pavement to remain in place shall be severed.

In areas where the roadway is to be overlaid with hot mix asphalt one lane at a time, rubblizing shall extend a minimum of 15 cm beyond the edge of pavement to be overlaid

361.07.02 Compaction of Granular A

Compaction of Granular A shall be according to OPSS 501.

361.07.03 Gradation Requirement for Rubblized Concrete

The rubblized concrete shall meet the following gradation requirements:

a) No particles shall exceed 150 mm in the largest dimension.

b) A maximum of 10%, by mass, shall pass the 75 µm sieve.

Any pieces of rubblized concrete greater than 150 mm shall be removed or reduced to an acceptable size. The resulting void shall be replaced with compacted Granular A material.

361.07.04 Test Section

The proposed rubblizing operation shall be demonstrated over a 100 m full width test section. The test section location shall be subject to the approval of the Contract Administrator.

The resultant rubblized concrete shall meet the specified requirements. When the rubblizing operation does not conform to the specification, appropriate adjustments shall be made to the operation to ensure conformance to the specification and an additional test section shall be performed.

361.07.05 Compaction and Proof Rolling

The rubblized concrete shall be compacted with a minimum of two passes, each pass being up and back, of the self-propelled, vibratory, single smooth steel drum grade roller. The roller shall be operated at a speed not exceeding 5 km/h. Where deflections and associated movement of the rubblized concrete surface are apparent, remedial action shall be taken as directed by the Contract Administrator.

361.07.06 Sampling

A minimum of one sample per day of production shall be taken on a random basis at locations determined by the Contract Administrator. The sample size shall be a minimum of one square metre for the full depth of the rubblized concrete, including the embedded steel. The sampling frequency may be reduced at the discretion of the Contract Administrator. The removed rubblized material shall be visibly inspected by the Contract Administrator for conformance to the specification.

After sampling, the sampled area shall be backfilled and compacted with Granular A material.

361.07.07 Embedded Steel

All embedded steel reinforcement in the rubblized concrete shall be left in place. Where reinforcement is present, the bond between the concrete and the reinforcement shall be broken. Any steel exposed or protruding above the surface shall be cut off flush with the surface and removed from the site.

361.07.08 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

361.09 MEASUREMENT FOR PAYMENT

361.09.01 Actual Measurement

361.09.01.01 Rubblizing of Concrete Pavement
Rubblizing of Concrete Base

Measurement of rubblizing of concrete pavement and concrete base shall be by area in square metres.

361.09.02 Plan Quantity Payment

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clause under Actual Measurement.

361.10 BASIS OF PAYMENT

361.10.01 Rubblizing of Concrete Pavement - Item
Rubblizing of Concrete Base - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Asphalt removal shall be paid for under a separate item.

Appendix 361-A, November 2019
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

Other concrete pavement rehabilitation treatments should be considered prior to specifying rubblizing. For effective rubblizing, the concrete slab shall be free of delamination and material deterioration.

This specification is written as a method specification identifying a unique process incorporating a resonant frequency pavement breaker. Gradation control of the final product is based on visual assessment of the rubblized material. When greater gradation control is required of the final product, full depth removal of the concrete pavement and off-site crushing is recommended.

All overlying bituminous material shall be fully removed prior to rubblizing. Payment for removal of bituminous material shall be under separate items.

The designer should ensure that areas previously repaired with full depth asphalt are removed to ensure uniform performance of the rubblized material.

Proper subgrade support for the rubblizing operation shall be assessed during precontract engineering.

Granular A material for backfill purposes may be substituted with an alternate crushed granular material. When paving directly on the rubblized surface, a hot mix asphalt levelling course is recommended. If an alternate material is required, this must be indicated in the Contract Documents.

The designer should identify the thickness of the concrete slab to be rubblized and identify the type of embedded steel in the concrete slab.

Pavement drainage systems including ditch, sub-drains, and outlets are to be staged so that they are installed and operational prior to rubblizing operations beginning.

Operations should be staged so that the lateral pavement edge support remains in place until the rubblizing operations are completed. This is to ensure that the maximum impact energy is transferred to the concrete slab.

Since only construction traffic is permitted on the rubblized surface, traffic staging should be shown in the Contract Documents.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

CONSTRUCTION SPECIFICATION FOR PARTIAL DEPTH REPAIRS IN CONCRETE PAVEMENT

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364.09 MEASUREMENT OF PAYMENT

364.10 BASIS OF PAYMENT

APPENDICES

364-A Commentary

364.01 SCOPE

This specification covers the requirements for partial depth repairs in concrete pavement and includes removal of concrete, preparation of surfaces, placement of concrete, and forming joints associated with the repairs.

364.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be as specified in the Contract Documents.

364.01.02 Appendices Significance and Use

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364.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 350	Concrete Pavement, Concrete Base and Lean Concrete Base
OPSS 904	Concrete Structures
OPSS 929	Abrasive Blast Cleaning - Concrete Construction

Ontario Provincial Standard Specifications, Material

OPSS 1002	Aggregates - Concrete
OPSS 1350	Concrete, Materials and Production

364.03 DEFINITIONS

For the purposes of this specification the following definitions shall apply:

Partial Depth Repairs means areas of concrete pavement repair to a minimum depth of 50 mm and a maximum depth of one-third the thickness of the existing concrete slab.

Working Cracks means full depth cracks which are subject to horizontal or vertical movement or both.

364.05 MATERIALS

364.05.01 Coarse Aggregate

Coarse aggregates shall be according to OPSS 1002 with a nominal maximum aggregate size of 19 mm.

364.05.02 Bonding Agent for Surface Preparation

Bonding agent for surface preparation shall be as specified in Contract Documents.

364.05.03 Concrete

Concrete shall be according to OPSS 1350.

364.07 CONSTRUCTION

364.07.01 General

The Contract Administrator shall clearly delineate the limits of the repair area. The perimeter of the concrete pavement repair area shall be saw cut vertically to a depth of 50 mm. The concrete within the saw cut area shall be removed to a minimum depth of 50 mm and a maximum depth of one-third the thickness of the existing concrete slab using equipment that prevents the fracture of the underlying sound concrete. Wire mesh in the concrete shall be removed to the edge of the repair.

The area shall be abrasive blast cleaned according to OPSS 929. Immediately prior to filling the repair area with concrete, the surface area of the repair shall be uniformly coated with a bonding agent as specified in Contract Documents. The repair area shall then be filled with concrete, finished flush with the adjacent surface in accordance with OPSS 1350, and cured according to OPSS 904.

364.07.01.01 Joints and Working Cracks

When the partial depth repair area includes an existing pavement joint or working crack, a joint shall be formed in the repair area to match the existing pavement joint or working crack. The joint shall be formed by placing a compressible joint material along the cut line in such a manner that prevents the plastic concrete from infiltrating the existing joint or crack. The width of compressible material shall match the existing joint or working crack. Prior to placement of compressible material, joints or working cracks shall be blown clean with compressed air.

364.07.02 Miscellaneous Protection

Miscellaneous protection for partial depth repairs in concrete pavement shall be according to OPSS 350.

364.07.02.01 Traffic

For early opening determination, one set of test cylinders shall be taken from the last load of concrete placed in the pavement section to be opened to traffic. The test cylinders shall be field cured adjacent to the repair area. Early opening to traffic shall be according to OPSS 350.

364.07.03 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

364.09 MEASUREMENT OF PAYMENT

364.09.01 Actual Measurement

364.09.01.01 Partial Depth Repairs in Concrete Pavement

Measurement shall be in square metres of the horizontal area repaired.

364.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the unit shown in the clause under Actual Measurement.

364.10 BASIS OF PAYMENT

364.10.01 Partial Depth Repairs in Concrete Pavement - Item

Payment at the contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

Appendix 364-A, November 2021
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

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Designer Action/Considerations

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

- Bonding agent for surface preparation. (364.05.02)

- When specified, cement paste should consist of normal Portland cement according to OPSS 1301 and sufficient water to produce a paste that can be applied with a brush. Cement paste not used within 30 minutes should be discarded. (364.05.02)

- Where other bonding agents are available, they will be specified in Contract Documents. (364.07.01)

- Coating with a bonding agent. (364.07.01)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 560.040 Partial Depth Repairs in Concrete Pavement

CONSTRUCTION SPECIFICATION FOR CROSS-STITCHING LONGITUDINAL CRACKS IN CONCRETE PAVEMENT AND CONCRETE BASE

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365-A Commentary

365.01 SCOPE

This specification covers the requirements for cross-stitching longitudinal cracks in concrete pavement and concrete base.

365.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

365.01.02 Appendices Significance and Use

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365.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 369 Sealing or Resealing of Joints and Cracks in Concrete Pavement and Concrete Base

Ontario Provincial Standard Specifications, Material

OPSS 1440 Steel Reinforcement for Concrete
OPSS 1442 Epoxy Coated Reinforcing Steel Bars for Concrete

Ontario Ministry of Transportation Publications

Designated Sources for Materials (DSM)

365.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Cross-stitching means tying together concrete pavement or concrete base across a longitudinal crack using deformed tie bars epoxied into holes drilled at an angle across the crack. This prevents horizontal and vertical movement of the concrete crack and migration of the adjacent slabs.

365.05 MATERIALS

365.05.01 Tie Bars

Tie bars shall be deformed tie bars according to OPSS 1440 and as specified in the Contract Documents. Tie bars shall be epoxy coated according to OPSS 1442.

365.05.02 Epoxy Adhesive

Epoxy adhesive shall be of the type specified for horizontal dowel application and mixed in the nozzle or cartridge. Epoxy adhesive shall be supplied from a source on the MTO DSM.

365.06 EQUIPMENT

365.06.01 Drill

A hydraulic or pneumatic drill shall be used to drill holes in the concrete pavement or concrete base. The drill shall be frame mounted and capable of drilling at a 35 or 45 degree angle to the horizontal. Drilling equipment shall be used in a manner to ensure adjacent concrete is not damaged.

365.06.02 Compressor - Air Blasting

The compressor for air blasting shall have a minimum capacity of 3.5 m^3/min. The compressed air shall be free from oil and other contaminants.

365.07 CONSTRUCTION

365.07.01 Tie Bar Installation

Tie bars shall be installed as specified in the Contract Documents at locations identified by the Contract Administrator. A minimum of two deformed tie bars shall be cross-stitched through a single longitudinal crack.

Holes for the tie bars shall be drilled at an angle to the horizontal, alternating across opposite sides of the crack to produce a cross-stitching pattern. The diameter of the drill hole shall be no more than 5 mm larger than the diameter of the tie bar. Drill holes shall be located such that the tie bar intersects the longitudinal crack at approximately mid-depth of the concrete slab. Drill holes shall not exit the bottom of the concrete slab.

Drilling angle, depth, diameter, and offset shall be as specified in Contract Documents and shall be installed as per the following tolerances:

a) Drilling angle: $\pm$ 1°

b) Drill hole depth: $\pm$ 5 mm

c) Drill hole diameter: $\pm$ 1 mm

d) Drill hole offset from longitudinal crack: $\pm$ 5 mm

Prior to tie bar installation, drill holes shall be thoroughly cleaned with compressed air by inserting the compressor nozzle for the full length of the drilled hole.

The tie bars shall be secured into the existing concrete with epoxy adhesive. The epoxy adhesive shall be injected into the cleaned drill hole from the bottom of the hole outward. The tie bars shall be inserted to ensure the bars are completely encased with epoxy adhesive for the full depth of the drill hole. Excess epoxy shall be removed from the surface of the pavement.

365.07.02 Sealing of Longitudinal Cracks

Upon completion of tie bar installation the longitudinal crack shall be sealed according to OPSS 369.

365.07.03 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

365.08 QUALITY ASSURANCE

365.08.01 Inspection

The Contractor shall allow the Contract Administrator to inspect all drill holes prior to placing the tie bars to ensure they meet the requirements of the Contract Documents.

365.08.02 Rejection

Drill holes identified by the Contract Administrator as not meeting the requirements of the Contract Documents shall be filled with epoxy and abandoned.

365.09 MEASUREMENT OF PAYMENT

365.09.01 Actual Measurement

365.09.01.01 Cross-Stitching

For measurement purposes, a count shall be made of the number of tie bars installed.

365.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

365.10 BASIS OF PAYMENT

365.10.01 Cross-Stitching - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

Drill holes not within the specified tolerances shall be filled with epoxy and abandoned at no additional cost to the Owner.

365.10.02 Sealing of Longitudinal Cracks

Payment for the sealing of longitudinal cracks shall be according to OPSS 369.

Appendix 365-A, November 2020
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Tie bar size and length requirements. (365.05.01)

- Tie bar installation requirements. (365.07.01)

- Drilling angle, depth, diameter, and offsets. (365.07.01)

- Tender item for sealing the longitudinal cracks. (365.07.02 and 365.10.02)

Cross-stitching is a method used to tie together longitudinal cracks in concrete pavement and concrete base. Cross-stitching can be applied to longitudinal cracks that are in reasonably good condition. The purpose of cross-stitching is to maintain aggregate interlock, provide added reinforcement to cracks, and prevent horizontal and vertical movement of the concrete crack and slab migration. As this process is not suitable for transverse cracks, consideration should be given to specifying dowel bar retrofits.

Pre-design investigation should determine the thickness of the concrete slab over the length of the pavement. The thickness of the concrete should be specified in the Contract Documents.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 560.025 Concrete Pavement and Concrete Base, Cross-Stitching Longitudinal Cracks

CONSTRUCTION SPECIFICATION FOR SEALING OR RESEALING OF JOINTS AND CRACKS IN CONCRETE PAVEMENT AND CONCRETE BASE

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369-A **Commentary**

369.01 SCOPE

This specification covers the requirements for sealing or resealing of joints and cracks up to 25 mm in width in concrete pavement and concrete base.

369.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be as specified in the Contract Documents.

369.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

369.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 350 Concrete Pavement and Concrete Base
OPSS 929 Abrasive Blast Cleaning - Concrete Construction

Ontario Provincial Standard Specifications, Material

OPSS 1212 Hot Poured Rubberized Asphalt Joint Sealing Compound

ASTM International

D 2628-91(2016) Preformed Polychloroprene Elastomeric Joint Seals for Concrete Pavements

369.03 DEFINITIONS

For the purpose of this specification, the following definitions shall apply:

Backer Rod means a compressible material inserted into the reservoir to achieve the required shape factor for the sealant and prevent loss of sealant.

Reservoir means a saw cut cavity of specific dimensions designed to receive the backer rod and sealant or seal.

Shape Factor means the ratio of width to depth of a field poured liquid sealant within the reservoir.

369.05 MATERIALS

369.05.01 Sealants

Hot poured rubberized asphalt joint sealing compound shall be according to OPSS 1212.
Silicone sealant shall be as specified in the Contract Documents.

369.05.02 Seals

Preformed compression seals shall meet the manufacturer's requirements according to ASTM D 2628.

369.05.03 Backer Rods

Backer rods shall be made of polyethylene foam, cross-linked polyethylene foam, or polyurethane foam.

369.06 EQUIPMENT

369.06.01 Saw Cutting Equipment

Saw cutting equipment shall be capable of following the path of random cracks to create a sealant reservoir to the dimensions specified in the Contract Documents, without causing spalling or damage to the adjacent concrete.

The saw shall be power driven and equipped with a diamond blade having a diameter of 200 mm or less.

369.06.02 Heating Kettle

When required, the heating kettle shall be designed and operated to ensure uniform heat and to agitate and prevent overheating of the sealant.

369.06.03 Hot Compressed Air Lance

The hot compressed air lance shall have an oil free discharge of air at a temperature greater than 1,000 °C and an air velocity greater than 1,000 m per second.

369.07 CONSTRUCTION

369.07.01 General

Joints and cracks identified in the Contract Documents and in the field by the Contract Administrator shall be filled with hot poured rubberized joint sealing compound. Preformed compression seals or silicone sealant shall be used when specified in the Contract Documents.

The maximum width of repair shall be 25 mm for both transverse and longitudinal cracks and joints. Cracks and joints exceeding the maximum repair width shall be repaired as directed by the Contract Administrator.

369.07.02 Operational Constraints

Grinding and milling operations shall be completed prior to sealant installation.

Sealant or seals shall not be placed until new concrete has cured for a minimum of 7 Days.

Cracks and joints shall be kept in a dry condition for a minimum period of 24 hours prior to sealant or seal installation.

Sealant shall not be placed when the ambient air and pavement surface temperatures are less than 5 °C. Seals shall be placed according to the manufacturer's recommendations.

369.07.03 Removal of Existing Sealant and Seals

All existing sealant and seals shall be removed without damaging the adjacent joint or crack faces.

369.07.04 Reservoir

Saw cutting equipment shall be used to create a reservoir with dimensions specified in the Contract Documents. Routers shall not be used for creating the reservoir.

The shape factor shall be 1H:1V for hot poured rubberized sealant and 2H:1V for silicone sealant.

When resealing cracks or joints, if the existing reservoir is determined by the Contract Administrator to be in an acceptable condition with minimal spalling and to have the proper dimensions, saw cutting shall not be required, but cleaning shall be required.

369.07.05 Cleaning

Immediately after the sawing operation, reservoirs shall be flushed with water in one direction to remove the slurry. Immediately prior to sealing operations, all joint and crack faces shall be abrasive blast cleaned according to OPSS 929. The reservoir shall then be blown clean and dried using a hot compressed air lance.

369.07.06 Backer Rod Installation

Backer rods shall have a minimum diameter of 25% greater than the reservoir width. They shall be installed immediately after cleaning and drying and before sealant installation. Backer rods shall be inserted uniformly to the required depth to achieve the required shape factor.

Backer rods shall be inserted using a double wheel steel roller and shall not be punctured or stretched during the installation process.

369.07.07 Sealant and Seal Installation

369.07.07.01 General

Prepared transverse joints and cracks shall be filled prior to longitudinal joints and cracks.

Sealant and seals shall be installed according to the manufacturer’s recommendations.

369.07.07.02 Hot Poured Rubberized Joint Sealing Compound

The sealant shall be placed by a manual pouring cone or hose and wand fitted with a proper sized tip from a low pressure pump connected to the heating kettle.

The tip of the cone or wand shall be placed to the top of the backer rod to ensure uniform application.

The reservoir shall be filled with sealant so that upon cooling, the sealant is recessed 3 to 6 mm below the adjacent pavement surface. If the initial placement of material subsides below the required recess depths, additional sealant shall be placed.

Sealant damaged by construction traffic or by the Contractor's operations shall be replaced.

Any spilled material or excess material in the joints or cracks shall be removed immediately and the pavement surface cleaned.

The quantity of material heated shall be placed to permit use on the same day. Excess heated material shall be disposed of and is not permitted to be used on subsequent days.

369.07.07.03 Compression Seal

After final cleaning of the reservoir, the lubricant adhesive shall be applied to the seal and the seal shall be installed according to the manufacturer's specifications. During installation, twisting, nicking, or other damage to the seal shall be avoided.

369.07.07.04 Silicone Sealant

Installation of silicone sealant shall be as specified in the Contract Documents and according to manufacturer's recommendations.

369.07.08 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

369.08 QUALITY ASSURANCE

During the process of sealant or seal installation, upon request, the Contractor shall provide a sample of the seal or seal for testing to the Contract Administrator.

Sealant samples shall be stored in triple-tight epoxy-lined pails or suitable leak-proof plastic containers.

Seal samples shall be a minimum 1 m in length.

All samples shall be accompanied by a sample data sheet and any additional documents as specified in the Contract Documents. When not specified or not included on the sample data sheet, samples shall be delivered with a transmittal form identifying the following information:

a) Contract number.

b) Name of Contractor and a contact person's name and telephone numbers.

c) Contract Administrator's name and telephone numbers.

d) Quantity and type of sample. When a sample consists of more than one item, each item shall be individually identified.

e) Date sampled (i.e., yyyy-mm-dd).

f) Date shipped.

g) Sample location.

369.09 MEASUREMENT FOR PAYMENT

369.09.01 Actual Measurement

369.09.01.01 Resealing of Joints and Sealing or Resealing of Cracks in Concrete Pavement and Concrete Base

Measurement of resealing of joints and sealing or resealing of cracks in existing concrete pavement or concrete base shall be by length in metres measured along the centreline of the crack or joint.

369.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clause under Actual Measurement.

369.10 BASIS OF PAYMENT

369.10.01 Resealing of Joints and Sealing or Resealing of Cracks in Concrete Pavement and Concrete Base - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

Sealant or seals damaged by construction traffic or by the Contractor's operations shall be replaced at no extra cost to the Owner.

Removal of excess or spilled sealant shall be at no extra cost to the Owner.

Payment for the sealing of joints in new concrete pavement shall be paid according to OPSS 350.

Appendix 369-A, November 2018
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The specification is appropriate for use on cracks and joints up to 25 mm in width. For widths greater than 25 mm in width, the designer should consider alternative remedial treatments.

The designer should specify the following in the Contract Documents:

- Sealant reservoir dimensions. (369.06.01)

- Installation requirements for silicone sealant. (369.07.07.04)

The designer should determine if the following is required and, if so, specify it in the Contract Documents:

- Material requirements for silicone sealant. (369.05.01)

- Joint sealing using preformed compression seals or silicone sealant. (369.07.01)

The designer should estimate tender quantities for resealing of cracks and existing joints and sealing of cracks required under this item. The tender quantity should not include the sealing of joints in new concrete pavement.

A pavement condition survey is recommended to determine the extent of the joint and crack sealing or resealing required.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 508.020	Sealing or Resealing of Joints and Cracks in Concrete Pavement and Concrete Base
OPSD 552.010	Concrete Pavement, Joint Details

CONSTRUCTION SPECIFICATION FOR TRENCHING, BACKFILLING, AND COMPACTING

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401-A Commentary

401.01 SCOPE

This specification covers the requirements for excavating, backfilling, and compacting trenches for the installation of pipe, end sections, and associated appurtenances.

401.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

401.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

401.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 206	Grading
OPSS 403	Rock Excavation for Pipelines, Utilities, and Associated Structures in Open Cut
OPSS 404	Support Systems
OPSS 412	Sewage Forcemain Installation in Open Cut
OPSS 441	Watermain Installation in Open Cut
OPSS 490	Site Preparation for Pipelines, Utilities, and Associated Structures
OPSS 491	Preservation, Protection, and Reconstruction of Existing Facilities
OPSS 492	Site Restoration Following Installation of Pipelines, Utilities, and Associated Structures
OPSS 501	Compacting
OPSS 510	Removal
OPSS 517	Dewatering for Excavations
OPSS 539	Temporary Protection Systems
OPSS 902	Excavating and Backfilling - Structures

Ontario Provincial Standard Specifications, Material

OPSS 1010	Aggregates - Base, Subbase, Select Subgrade, and Backfill Material
OPSS 1359	Unshrinkable Backfill

Provincial Statute

O. Reg. 213/91	Construction Projects

401.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Associated Appurtenances means as defined in OPSS 412 and OPSS 441.

Backfilling means the operation of filling the trench with bedding, cover, and backfill material or embedment and backfill material.

Backfill Material means fill material used above the embedment or cover material and below the lower of the subgrade or finished grade or the original ground.

Bedding Class means a classification system that defines the depth of the bedding material.

Bedding Material means material as it relates to rigid pipe, from the bottom of the trench to the bottom of the cover.

Cover Material means the material placed from the top of the bedding to the bottom of the backfill for rigid pipe.

Deleterious Material means materials from the recycling stream other than glass, ceramic, reclaimed asphalt pavement, and reclaimed concrete materials that includes but is not limited to the following: wood, clay brick, clay tile, plastic, gypsum, gypsum plaster, and wallboard.

Embedment Material means material as it relates to flexible pipe, from the bottom of the trench to the bottom of the backfill.

Excavation, Earth and Rock means the excavation classified as earth and rock according to OPSS 206.

Extra Excavation means all excavation ordered in writing by the Contract Administrator beyond excavation as specified in the Contract Documents.

Flexible Pipe means pipe that can deflect 2% or more without cracking such as polyvinyl chloride, polyethylene, or steel pipe.

Imported Material means material obtained from a source other than the Working Area.

Native Material means the material removed to form an excavation within the Working Area for return to the same or other excavation.

Pipe means sanitary or storm pipe sewers, watermains, forcemains, pipe culverts, and subdrains.

Rigid Pipe means pipe that cannot deflect more than 2% without cracking such as concrete pipe.

Trench means as defined in O. Reg 213/91.

Trenching means the earth or rock excavation required to construct a trench in which to install pipes and their associated appurtenances.

Trench Width means the horizontal distance between the trench walls as measured at the bedding grade.

Unshrinkable Fill means as defined in OPSS 1359.

401.05 MATERIALS

401.05.01 Bedding Material and Embedment Material

Bedding and embedment materials shall be one of the following, or as specified in the Contract Documents:

a) Granular A.

b) Granular B, Type I, II, or III, with 100% passing the 26.5 mm sieve.

c) Unshrinkable fill.

401.05.02 Cover Material

Cover material shall be one of the following, or as specified in the Contract Documents:

a) Granular A.

b) Granular B, Type I, II, or III, with 100% passing the 26.5 mm sieve.

401.05.03 Granular Material

Granular material shall be according to OPSS 1010.

401.05.04 Backfill Material

401.05.04.01 General

Backfill material shall be one of the following, or as specified in the Contract Documents:

a) Granular A.

b) Granular B, Type I, II, or III.

c) Unshrinkable fill.

d) Native material.

401.05.04.02 Native and Imported Material

Only native and imported material approved by the Contract Administrator shall be used. All material shall be free from frozen lumps, cinders, ashes, organic matter, rocks and boulders over 150 mm in any dimension, and other deleterious material.

401.05.05 Unshrinkable Fill

Unshrinkable fill shall be according to OPSS 1359.

401.07 CONSTRUCTION

401.07.01 General

Trenches shall be stable and dry, unless designated by the Contract Administrator as subaqueous Work.

401.07.02 Site Preparation

Site preparation shall be according to OPSS 490.

401.07.03 Preservation and Protection of Existing Facilities

Preservation and protection of existing facilities shall be according to OPSS 491.

401.07.04 Removals

Removals shall be according to OPSS 510.

401.07.05 Dewatering

Dewatering shall be according to OPSS 517 for placement of pipe or to OPSS 902 for placement of structures.

401.07.06 Support Systems

Support systems shall be according to OPSS 404.

401.07.07 Temporary Protection Systems

The construction of all temporary protection systems shall be according to OPSS 539. When the stability, safety, or function of an existing roadway, railway, other works, or proposed works may be impaired due to the method of operation, appropriate protection shall be provided. Protection may include sheathing, shoring, and the driving of piles, when necessary.

401.07.08 Removal of Frozen Ground

Written permission shall be obtained from the Contract Administrator prior to starting any excavation in frozen ground. The method used for removal of frozen ground shall not cause damage to adjacent structures or Utilities.

401.07.09 Trenching

Trenches shall be excavated to the lines, grades, and dimensions specified in the Contract Documents. The width of the trench at the bottom shall not exceed the width at the top.

Trenching for pipe culverts shall include the excavation for frost tapers and end sections.

No more than 15 m of trench shall be open in advance of the completed pipe system.

The Contract Administrator shall be notified immediately if the bottom of the trench appears to give an unsuitable foundation.
When installing rigid pipe, if the trench is excavated wider than the allowable width without authorization, the Contract Administrator may require the use of a stronger pipe or a higher bedding class or both.

If the trench depth is excavated beyond the limits of the required excavation without the Contract Administrator's authorization, granular material shall be placed and compacted in the trench to reinstate the required trench limits prior to backfilling the trench as specified in the Contract Documents. Alternatively, another structurally accepted design shall be provided by adjusting the limits of the excavation prior to backfilling.

Rock excavation for trenches shall be according to OPSS 403.

401.07.10 Backfilling and Compacting

401.07.10.01 General

Allowable deflection in diameter of flexible pipe during cover and backfill operations shall be as per manufacturer's recommendations.

Compacting of embedment, bedding, cover, and backfill materials during pipe installation shall be according to OPSS 501.

Prior to allowing the movement of any construction equipment or vehicular traffic over the buried infrastructure, the depth of backfill shall be sufficient enough to protect the buried infrastructure from damage.

401.07.10.02 Embedment

Placement of embedment material shall be as described in the Bedding and Cover clauses.

401.07.10.03 Bedding

Pipe bedding shall be of the class as specified in the Contract Documents.

The surface upon which the pipe is to be laid shall be true to grade and alignment.

The pipe bedding shall be shaped to the dimensions specified in the Contract Documents. When bell and spigot pipe is to be laid, recesses shall be shaped to receive the bells.

Bedding material placed in the haunches shall be compacted prior to continued placement of cover material.

Bedding material shall be placed in uniform layers not exceeding 200 mm in thickness, loose measurement, and each layer shall be compacted according to OPSS 501 before a subsequent layer is placed.

Bedding material shall be placed on each side of the pipe and shall be completed simultaneously. At no time shall the levels on each side differ by more than the 200 mm uncompacted layer.

401.07.10.04 Cover

Cover material shall be placed so that damage to or movement of the pipe is avoided.

Cover material shall be placed in uniform layers not exceeding 200 mm in thickness, loose measurement, and each layer shall be compacted according to OPSS 501 before a subsequent layer is placed.

Cover material shall be placed on each side of the pipe and shall be completed simultaneously. At no time shall the levels on each side differ by more than the 200 mm uncompacted layer.

401.07.10.05 Backfill

Backfill material shall be placed in uniform layers not exceeding 300 mm in thickness, loose measurement, for the full width of the trench and each layer shall be compacted according to OPSS 501 before a subsequent layer is placed.

Power operated tractors or rolling equipment shall not be used for compacting until backfill material has been placed to a minimum depth of 900 mm above the crown of the pipe. Uniform layers of backfill material exceeding 300 mm in thickness may be placed with the approval of the Contract Administrator.

401.07.11 Extra Trenching, Backfilling, and Compacting

Extra trenching, backfilling, and compacting shall be as described in the Trenching and Backfilling and Compacting subsections.

Unsuitable material shall be excavated and the resulting excavation shall be backfilled and compacted to obtain a suitable foundation.

401.07.12 Site Restoration

Site restoration shall be according to OPSS 492.

401.07.13 Management of Excess Material

Management of excess material shall be as specified in the Contract Documents.

401.09 MEASUREMENT FOR PAYMENT

401.09.01 Actual Measurement

401.09.01.01 Extra Trenching, Backfilling, and Compacting

Extra trenching, backfilling, and compacting shall be based on the volume of the extra excavation measured in cubic metres prior to installation of the pipe.

The volume of the excavation that is in addition to the limits specified in the Contract Documents shall be determined.

401.10 BASIS OF PAYMENT

401.10.01 Trenching, Backfilling, and Compacting

Payment at the Contract price for the appropriate tender items for the installation of pipe, end sections, and associated appurtenances, shall be full compensation for all labour, Equipment, and Material to do the work.

When the Contract contains separate items for work required by this specification, payment shall be at the Contract prices and according to the specifications for such work.

Any expenses for remedial work resulting from unauthorized over-excavation of the trench width and depth shall be at no additional cost to the Owner.
When native material is deemed unsuitable for backfill for reasons other than those attributed to the Contractor's mode of operation, any extra work done to provide acceptable backfill beyond the work herein specified shall be paid for as Extra Work.

401.10.02 Extra Trenching, Backfilling, and Compacting - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

401.10.03 Rock Excavation for Trenches

Payment for rock excavation for trenches shall be according to OPSS 403.

Appendix 401-A, November 2021
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer may consider including soil boring data, a geotechnical report, a subsurface report, or a soils report in the tender documents.

The designer may consider specifying requirements for a pre-condition survey in the Contract Documents.

The designer should specify the following in the Contract Documents:

- Extra excavation. (401.03)

- Type of embedment material. (401.05.01)

- Type of bedding material. (401.05.01)

- Type of cover material. Unshrinkable fill or native material may be a consideration in the cover (401.05.02)

- Type of backfill material. (401.05.04.01)

- Trench line, grade, and dimensions. (401.07.09)

- Pipe bedding class and dimensions. (401.07.10.03)

- Volume of the excavation that is in addition to the limits. (401.09.01.01)

For utilities, the designer should reference their respective trenching, backfilling, and compaction details.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 802.010	Flexible Pipe Embedment and Backfill, Earth Excavation
OPSD 802.013	Flexible Pipe Embedment and Backfill, Rock Excavation
OPSD 802.014	Flexible Pipe Embedment in Embankment, Original Ground: Earth or Rock
OPSD 802.020	Flexible Pipe Arch Embedment and Backfill, Earth Excavation
OPSD 802.023	Flexible Pipe Arch Embedment and Backfill, Rock Excavation
OPSD 802.024	Flexible Pipe Arch Embedment in Embankment, Original Ground: Earth or Rock
OPSD 802.030	Rigid Pipe Bedding, Cover and Backfill, Type 1 or 2 Soil - Earth Excavation
OPSD 802.031	Rigid Pipe Bedding, Cover and Backfill, Type 3 Soil - Earth Excavation
OPSD 802.032	Rigid Pipe Bedding, Cover and Backfill, Type 4 Soil - Earth Excavation
OPSD 802.033	Rigid Pipe Bedding, Cover and Backfill, Rock Excavation
OPSD 802.034	Rigid Pipe Bedding and Cover in Embankment, Original Ground: Earth or Rock
OPSD 802.050	Horizontal Elliptical Rigid Pipe Bedding, Cover and Backfill, Type 1 or 2 Soil - Earth Excavation
OPSD 802.051	Horizontal Elliptical Rigid Pipe Bedding, Cover and Backfill, Type 3 Soil - Earth Excavation
OPSD 802.052	Horizontal Elliptical Rigid Pipe Bedding, Cover and Backfill, Type 4 Soil - Earth Excavation
OPSD 802.053	Horizontal Elliptical Rigid Pipe Bedding, Cover and Backfill, Rock Excavation

OPSD 802.054	Horizontal Elliptical Rigid Pipe Bedding and Cover in Embankment, Original Ground: Earth or Rock
OPSD 803.010	Backfill and Cover for Concrete Culverts
OPSD 803.030	Frost Treatment - Pipe Culverts, Frost Penetration Line Below Bedding Grade
OPSD 803.031	Frost Treatment - Pipe Culverts, Frost Penetration Line Between Top of Pipe and Bedding Grade

CONSTRUCTION SPECIFICATION FOR EXCAVATING, BACKFILLING, AND COMPACTING FOR MAINTENANCE HOLES, CATCH BASINS, DITCH INLETS, AND VALVE CHAMBERS

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402.08 **QUALITY ASSURANCE - Not Used**

402.09 **MEASUREMENT FOR PAYMENT**

402.10 **BASIS OF PAYMENT**

APPENDICES

402-A **Commentary**

402.01 SCOPE

This specification covers the requirements for excavating, backfilling, and compacting for the installation of storm and sanitary pipe sewer maintenance holes, storm sewer catch basins and ditch inlets, and valve chambers for watermains and forcemains.

402.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be as specified in the Contract Documents.

402.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

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Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

402.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 206	Grading
OPSS 403	Rock Excavation for Pipelines, Utilities, and Associated Structures in Open Cut
OPSS 404	Support Systems
OPSS 490	Site Preparation for Pipelines, Utilities, and Associated Structures
OPSS 491	Preservation, Protection, and Reconstruction of Existing Facilities
OPSS 492	Site Restoration Following Installation of Pipelines, Utilities, and Associated Structures
OPSS 501	Compacting
OPSS 510	Removal
OPSS 517	Dewatering of Pipeline, Utility, and Associated Structure Excavation

Ontario Provincial Standard Specifications, Material

OPSS 1010	Aggregates - Base, Subbase, Select Subgrade, and Backfill Material
OPSS 1359	Unshrinkable Backfill

402.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Additional Excavation means all excavation ordered in writing by the Contract Administrator beyond excavation specified in the Contract Documents.

Backfilling means the operation of filling the excavation with bedding and backfill material.

Backfill Material means approved fill material used above the bedding and below the lower of the subgrade or finished grade or original ground.

Bedding Material means the material used to support the maintenance hole, catch basin, ditch inlet, or valve chamber.

Excavation, Earth and Rock means the excavation classified as earth and rock according to OPSS 206.

Imported Material means material obtained from a source other than the Work Area.

Native Material means the material removed to form an excavation within the Work Area for return to the same or other excavation.

Over-Excavation means all excavation beyond that specified in the Contract Documents, performed without the written order of the Contract Administrator.

Structure means maintenance hole, catch basin, ditch inlet, or valve chamber.

Unshrinkable Fill means a controlled density cement treated aggregate material.

402.05 MATERIALS

402.05.01 Granular Material

Granular material shall be according to OPSS 1010.

402.05.02 Backfill Material

402.05.02.01 General

Backfill material shall be as specified in the Contract Documents.

402.05.02.02 Native and Imported Material

Native and imported material shall be material approved by the Contract Administrator. All material shall be free from frozen lumps, cinders, ashes, refuse, vegetable or organic matter, rocks, and boulders over 25 mm in any dimension, and other deleterious material.

402.05.03 Unshrinkable Fill

Unshrinkable fill shall be according to OPSS 1359.

402.07 CONSTRUCTION

402.07.01 General

Excavations shall be stable and dry, unless designated as subaqueous Work.

402.07.02 Site Preparation

Site preparation shall be according to OPSS 490.

402.07.03 Preservation and Protection of Existing Facilities

Preservation and protection of existing facilities shall be according to OPSS 491.

402.07.04 Removals

Removals shall be according to OPSS 510.

402.07.05 Dewatering

Dewatering shall be according to OPSS 517.

402.07.06 Support Systems

Support systems shall be according to OPSS 404.

402.07.07 Removal of Frozen Ground

Written permission shall be obtained from the Contract Administrator prior to starting an excavation in frozen ground. The method used for removal of frozen ground shall not cause damage to adjacent structures, roadways, or Utilities.

402.07.08 Excavation

402.07.08.01 General

Excavation shall be performed to the lines, elevations, and dimensions specified in the Contract Documents plus an allowance for support systems, where required.

Rock excavation for maintenance holes, catch basins, ditch inlets, or valve chambers shall be according to OPSS 403.

402.07.08.02 Additional Excavation

Structures shall not be placed or constructed on an unsuitable foundation as may be determined by the Contract Administrator.

Unsuitable material shall be excavated and the resulting excavation shall be backfilled and compacted to obtain a suitable foundation.

402.07.08.03 Over-Excavation

Corrective measures ordered by the Contract Administrator to rectify deficiencies caused by over-excavation shall be performed. Soil that has become disturbed by construction methods or procedures shall be removed and replaced with granular material compacted to 95% maximum dry density where the excavated surface is below or beside the proposed structure.

402.07.09 Backfilling and Compacting

402.07.09.01 Bedding

A 150 mm layer of granular bedding material shall be placed on the bottom of the excavation and compacted according to OPSS 501, prior to the placing of a structure.

402.07.09.02 Backfill

Backfill material shall be placed simultaneously on all sides of the structure in layers not exceeding 300 mm in thickness, loose measurement, and compacted according to OPSS 501, prior to the placement of a subsequent layer.

Backfill material shall not commence around cast-in-place concrete structures until approval has been obtained from the Contract Administrator.

402.07.10 Additional Excavating, Backfilling, and Compacting

Additional excavating, backfilling, and compacting shall be as described in the Excavation and Backfilling and Compacting subsections.

The volume of the excavation that is in addition to the limits specified in the Contract Documents shall be determined.

402.07.11 Site Restoration

Site restoration shall be according to OPSS 492.

402.07.12 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

402.09 MEASUREMENT FOR PAYMENT

402.09.01 Actual Measurement

402.09.01.01 Additional Excavating, Backfilling, and Compacting

Additional excavating, backfilling, and compacting shall be based on the volume of the additional excavation measured in cubic metres prior to installation of a structure.

The volume of the additional excavation shall be determined beyond the limits specified in the Contract Documents.

402.10 BASIS OF PAYMENT

402.10.01 Excavating, Backfilling, and Compacting for Maintenance Holes, Catch Basins, Ditch Inlets, and Valve Chambers

Payment at the Contract price for the appropriate tender items for the installation of maintenance holes, catch basins, ditch inlets, and valve chambers shall be full compensation for all labour, Equipment, and Material to do the work.

When the Contract contains separate items for work required by this specification, payment shall be at the Contract prices and according to the specifications for such work.

Any expenses for remedial work resulting from over-excavation shall be borne by the Contractor.

402.10.02 Additional Excavating, Backfilling, and Compacting - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

402.10.03 Rock Excavation for Maintenance Holes, Catch Basins, Ditch Inlets, and Valve Chambers

Payment for rock excavation for maintenance holes, catch basins, ditch inlets, and valve chambers shall be according to OPSS 403.

Appendix 402-A, Commentary for OPSS.MUNI 402, November 2016
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer may consider including soil boring data, a geotechnical report, a subsurface report, or a soils report in the tender documents.

The designer should specify the following in the Contract Documents:

- Type of backfill material. (402.05.02)

- Lines, elevations, and dimensions of structure excavation. (402.07.08.01)

- Investigate and resolve any overlapping work. (402.07.10.01)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 701.010 to 701.015	Precast Concrete Maintenance Holes, 1,200 mm to 3,600 mm in Diameter
OPSD 701.030 to 701.081	Precast Concrete Maintenance Hole Components, 1,200 mm to 3,600 mm in Diameter
OPSD 702.040 to 702.050	Precast Concrete Ditch Inlet Maintenance Hole, 1,200 mm x 1,200 mm
OPSD 703.011 to 703.015	Precast Concrete Single Inlet Flat Cap, 1,500 mm to 3,600 mm in Diameter
OPSD 703.021 to 703.024	Precast Concrete Twin Inlet Flat Cap, 1,500 mm to 3,000 mm in Diameter
OPSD 705.010 to 705.020	Precast Concrete Catch Basins
OPSD 705.030 to 705.040	Precast Concrete Ditch Inlets
OPSD 706.010 to 706.041	Precast Concrete Ditch Inlets with 1,500 mm to 3,000 mm Diameter Flat Cap
OPSD 1100.010	Cast-In-Place Chamber for Valves up to 350 mm Diameter
OPSD 1101.010	Precast Valve Chamber, 1,200 mm and 1,500 mm Diameter
OPSD 1101.012 to 1101.015	Precast Concrete Valve Chamber with Poured-In-Place Thrust Blocks, 1,800 mm x 2,400 mm
OPSD 1101.016 to 1101.019	Precast Concrete Valve Chamber with Poured-In-Place Thrust Blocks, 2,400 mm x 3,000 mm

CONSTRUCTION SPECIFICATION FOR ROCK EXCAVATION FOR PIPELINES, UTILITIES, AND ASSOCIATED STRUCTURES IN OPEN CUT

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403.08 **QUALITY ASSURANCE - Not Used**

403.09 **MEASUREMENT FOR PAYMENT**

403.10 **BASIS OF PAYMENT**

APPENDICES

403-A **Commentary**

403.01 SCOPE

This specification covers the rock excavation requirements for the installation of sanitary and storm pipe sewers, pipe culverts and end sections, forcemains and associated appurtenances, and watermains and associated appurtenances; underground Utilities; and maintenance holes, catch basins, ditch inlets, and valve chambers in open cut.

403.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be as specified in the Contract Documents.

403.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

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Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

403.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 206	Grading
OPSS 412	Sewage Forcemain Installation in Open Cut
OPSS 441	Watermain Installation in Open Cut

403.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Associated Appurtenances means as defined in OPSS 412 and OPSS 441.

Associated Structures means a maintenance hole, catch basin, ditch inlet, or valve chamber.

Rock means rock as defined in OPSS 206.

403.07 CONSTRUCTION

403.07.01 General

Rock excavation to install sanitary and storm pipe sewers, pipe culverts and end sections, forcemains and associated appurtenances, and watermains and associated appurtenances; underground Utilities; and maintenance holes, catch basins, ditch inlets, and valve chambers in open cut shall be performed to the lines and grades specified in the Contract Documents.

403.07.02 Use of Explosives

The requirements for the use of explosives shall be as specified in the Contract Documents.

403.07.03 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

403.09 MEASUREMENT FOR PAYMENT

403.09.01 Actual Measurement

403.09.01.01 Rock Excavation for Pipelines, Utilities and Associated Structures

Measurement shall be in cubic metres.

The volume of rock excavation for pipelines, Utilities, and associated structures shall be determined by the product of the relevant following dimensions measured in place:

a) Height

The height of rock excavation for pipelines, Utilities, and associated structures is the difference in elevation between the theoretical bottom of bedding and the lower of the top of the original rock or the top of shatter.

The top of the original rock shall be determined using one of the following methods:

i. Elevations taken after the overburden has been removed but before rock excavation.
ii. From rock surface elevations on both sides of the excavation after rock excavation has been completed.

b) Width

The width of rock excavation for pipelines and Utilities is the actual width of trench measured horizontally to a maximum of the specified trench width.

c) Length

The length of rock excavation for pipelines and Utilities is measured horizontally along the centreline of the trench to the outside limits of the backfill for the associated structures or to the outlet end of a pipe where it emerges from the rock.

d) Horizontal

The horizontal measurement for associated structures is the:

i. diameter at the external surfaces of a circular structure plus 300 mm all around; or
ii. the length and width to the external surfaces of a rectangular or square structure plus 300 mm on all sides.

Where the excavation for this item overlaps rock excavation for other items there shall be no deduction for the overlap.

The volume of boulders in an excavation shall be determined by the product of the three maximum rectilinear dimensions. Where boulders classified as rock are measured for payment, only the amount actually removed shall be considered for payment, the total volume of rock considered for payment shall not exceed the volume of excavation within the theoretical lines.

403.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

403.10 BASIS OF PAYMENT

403.10.01 Rock Excavation for Trenches and Associated Structures - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

Appendix 403-A, Commentary for OPSS.MUNI 403, November 2016
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer may consider including soil boring data, a geotechnical report, a subsurface report, or a soils report in the tender documents.

The designer should specify the following in the Contract Documents:

- Line and grade requirements of sanitary and storm pipe sewers, pipe culverts and end sections, forcemains and associated appurtenances, and watermains and associated appurtenances; underground Utilities; and maintenance holes, catch basins, ditch inlets, and valve chambers. (403.07.01)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

Note: The MUNI implemented in November 2017 replaces OPSS 404 COMMON, November 2010 with no technical content changes.

CONSTRUCTION SPECIFICATION FOR SUPPORT SYSTEMS

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404.08 **QUALITY ASSURANCE - Not Used**

404.09 **MEASUREMENT FOR PAYMENT**

404.10 **BASIS OF PAYMENT**

APPENDICES

D 404-A **Commentary**

404.01 SCOPE

This specification covers the requirements for supplying, placing, maintaining, and removing support systems required to permit the excavation and backfilling of trenches or excavations for the installation of sanitary and storm pipe sewers, pipe culverts and end sections, forcemains and associated appurtenances, watermains and associated appurtenances, and other underground Utilities; maintenance holes, catch basins, ditch inlets, and valve chambers; and any other specified subsurface construction.

404.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be as specified in the Contract Documents.

404.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

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404.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 412 Sewage Forcemain Installation in Open Cut
OPSS 441 Watermain Installation in Open Cut

Provincial Statute

Occupational Health and Safety Act
R.S.O. 1990,
c. O.1, as amended
Ontario Regulations 213/91 - Regulations for Construction Projects, as amended

404.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Associated Appurtenances mean as defined in OPSS 412 and OPSS 441.

Sheathing means the vertical members of the support system that are placed up against the walls of an excavation to directly resist the pressure exerted from the walls of the excavation. Sheathing may be either wood or steel sheet piling.

Support Systems means as described in the *Occupational Health and Safety Act* and Regulations for Construction Projects.

Trench means the definition as provided in the *Occupational Health and Safety Act* and Regulations for Construction Projects.

404.04 DESIGN AND SUBMISSION REQUIREMENTS

404.04.01 Submission Requirements

404.04.01.01 Pre-Condition Survey

When specified in the Contract Documents, a pre-condition survey shall be prepared for all buildings, Utilities, structures, roadway infrastructure, and facilities within 30 m of the location where the support system is to be installed. The pre-condition survey shall include, as a minimum: existing structural and cosmetic damage or defects.

A copy of the pre-condition survey shall be provided to the Contract Administrator upon request.

404.07 CONSTRUCTION

404.07.01 General

Support systems shall be supplied, placed, and maintained at the locations and elevations that are necessary or required to:

a) support and protect the sides and bottom of the excavation.

b) prevent undue disturbance or weakening of the supporting material below or beside the works.

c) prevent movement of ground which may disturb or damage the works, adjacent pavements, property, structures, or other works.

404.07.02 Installation

Support systems shall be placed so they can be removed as backfilling takes place without damage to the works and without settlement of or damage to adjacent pavements, property, structures, or other works.

404.07.03 Removal, Backfilling, and Compacting

As the excavation is backfilled, the support system shall be removed, unless it is specified in the Contract Documents to be left in place or approved by the Contract Administrator.

Support systems shall be withdrawn gradually as backfilling progresses. Backfill shall be placed and compacted in a manner that fills the voids left by pulled support systems. The procedure for extracting the support system and placing backfill shall ensure the backfill load is applied gradually and disturbance of the works or foundation material is avoided.

Backfill shall be placed and compacted around and over the support systems left in place. Support systems left in place shall be cut off as specified in the Contract Documents.

404.07.04 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

404.09 MEASUREMENT FOR PAYMENT

404.09.01 Actual Measurement

404.09.01.01 Support System Left in Place

Measurement for support systems left in place shall be based on the sheathing area for all sides of the excavation in square metres according to the following:

a) Height

The vertical distance of the sheathing actually left in place. If the sheathing is cut off less than 1,200 mm from its top then the actual vertical height placed shall be used.

b) Length

The horizontal distance along the line of the supported excavation from the beginning to the end of the sheathing left in place.

404.10 BASIS OF PAYMENT

404.10.01 Support Systems

Payment at the Contract price for the appropriate tender items for the installation of sanitary and storm pipe sewers, pipe culverts and end sections, forcemains and associated appurtenances, watermains and associated appurtenances, and other underground Utilities; maintenance holes, catch basins, ditch inlets or valve chambers; and any other specified subsurface construction shall include full compensation for all labour, Equipment, and Material to do the work.

404.10.02 Support Systems Left in Place - Item

Payment at the Contract price for the above tender item shall be full compensation for all Material left in place.

No additional payment shall be made for support systems left in place at the Contractor's option.

Appendix 404-A, November 2017
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer may consider including soil boring data, a geotechnical report, a subsurface report, or a soils report in the Tender Documents.

The designer should specify the following in the Contract Documents:

- If the support system is to be left in place and the cut-off elevation. (404.07.03)

The designer should determine if a pre-condition survey is required and, if so, the need should be specified in the Contract Documents. (404.04.01)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 802.010 to 802.014	Flexible Pipe Embedment and Backfill
OPSD 802.020 to 802.024	Flexible Pipe Arch Embedment and Backfill
OPSD 802.030 to 802.034	Rigid Pipe Bedding, Cover, and Backfill
OPSD 802.050 to 802.054	Horizontal Elliptical Rigid Pipe Bedding, Cover, and Backfill

Note: The MUNI implemented in November 2017 replaces OPSS 405 COMMON, November 2008 with no technical content changes.

CONSTRUCTION SPECIFICATION FOR PIPE SUBDRAINS

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405.09 **MEASUREMENT FOR PAYMENT**

405.10 **BASIS OF PAYMENT**

APPENDICES

405-A **Commentary**

405.01 SCOPE

This specification covers the requirements for the installation of pipe subdrains.

405.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

405.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

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405.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 320	Open Graded Drainage Layer
OPSS 409	Closed-Circuit Television Inspection of Pipelines
OPSS 421	Pipe Culvert Installation In Open Cut
OPSS 501	Compacting

Ontario Provincial Standard Specifications, Material

OPSS 1004	Aggregates - Miscellaneous
OPSS 1010	Aggregates - Base, Subbase, Select Subgrade, and Backfill Material
OPSS 1801	Corrugated Steel Pipe Products
OPSS 1840	Non-Pressure Polyethylene Plastic Pipe Products
OPSS 1841	Polyvinyl Chloride (PVC) Pipe Products
OPSS 1860	Geotextiles

Canadian Standards Association (CSA)

G164-M92 (R2003) Hot Dip Galvanizing of Irregularly Shaped Articles

Bureau De Normalisation Du Quebec (BNQ)

3624-115 (2007) Polyethylene (PE) Pipe and Fittings - Flexible Corrugated Pipes for Drainage - Characteristics and Test Methods.

Water Research Centre (WRc) Publication

MSCC Manual of Sewer Condition Classification, 4th Edition, December 2003

405.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Backfilling means the operation of filling the trench with embedment and backfill material.

Backfill Material means the material used to fill the trench above the embedment material and below the lower of the subgrade or finished grade or the original ground.

Bedding means the embedment material placed in the subdrain and outlet pipe trenches below the pipe.

CCTV means closed-circuit television.

Embedment Material means the material used to fill the trench from the bottom of bedding to the height specified in the Contract Documents.

Knitted Sock Geotextile means a textile structure produced by knitting in a continuous tube specifically intended to cover perforated subdrain. Knitted geotextiles are suitable only for wrapping of perforated subdrain pipe.

OGDL means open graded drainage layer.

Outlet means the terminal 2.5 m of the outlet pipe.

Outlet Pipe means a non-perforated 100 or 150 mm diameter pipe that is placed for the purpose of conveying subsurface water from a subdrain to a proper outlet.

Subdrain means a perforated 100 or 150 mm diameter pipe that is placed for the purpose of collecting subsurface water and conveying it to a proper outlet pipe.

405.04 DESIGN AND SUBMISSION REQUIREMENTS

405.04.01 Submission Requirements

Upon request, prior to the placement of subdrain or outlet pipe, documentation from the manufacturer verifying that the material supplied meets the Contract requirements shall be submitted to the Contract Administrator.

405.05 MATERIALS

405.05.01 General

Subdrain shall be a perforated polyvinyl chloride pipe, polyethylene pipe, or corrugated steel pipe.

Outlet pipe shall be a non-perforated corrugated steel pipe or a non-perforated smooth inside wall pipe constructed of high density polyethylene or polyvinyl chloride.

Outlets shall be constructed of non-perforated corrugated steel pipe or double-walled polyethylene or polyvinyl chloride pipe having a minimum stiffness of 300 kPa.

405.05.02 Corrugated Steel Pipe Products

Corrugated steel pipe products shall be according to OPSS 1801 and as specified in the Contract Documents.

405.05.03 Polyethylene Pipe Products

Polyethylene pipe products shall be according to OPSS 1840 or BNQ 3624-115 and as specified in the Contract Documents.

405.05.04 Polyvinyl Chloride Pipe Products

Polyvinyl chloride pipe products shall be according to OPSS 1841 and as specified in the Contract Documents.

405.05.05 Geotextiles

Geotextiles shall be according to OPSS 1860 and as specified in the Contract Documents.

405.05.06 Fittings

Fittings shall be suitable for and compatible with the class and type of pipe with which they will be used.

Caps shall be polyethylene.

Galvanizing of rodent gates shall be according to CSA G164.

405.05.07 Granular

Granular material shall be according to OPSS 1010 and as specified in the Contract Documents.

405.05.08 Clear Stone

Clear stone shall be 19 mm, Type I or Type II, according to OPSS 1004.

405.05.09 Open Graded Drainage Layer Aggregate

OGDL aggregate shall be according to OPSS 320.

405.07 CONSTRUCTION

405.07.01 General

Contractor inspection reports shall confirm the following at each outlet pipe connection and at the midpoint between outlets:

a) Trench alignment, grade, and width.

b) Grade of bedding material.

c) Condition of subdrain, outlet pipe, and geotextile.

d) Compaction.

Contractor inspection reports shall be submitted to the Contract Administrator upon request.

Geotextile, subdrain, or outlet pipe damaged by exposure to sunlight or damaged by any other means shall be replaced.

The stability of the subdrain and outlet pipe trenches shall be maintained at all times during excavation and backfilling.

405.07.02 Excavation

Trenches shall be excavated to the lines, grades, and dimensions specified in the Contract Documents.

The excavation shall be inspected with grade checks and certified by the Contractor prior to placement of the pipe bedding.

405.07.03 Unstable Foundations

When unstable foundation conditions are encountered, the Contractor shall take the necessary steps to ensure a stable foundation as directed by the Contract Administrator. An inspection report to verify the foundation stability shall be submitted to the Contract Administrator upon request.

405.07.04 Geotexile

Subdrain shall be wrapped with a knitted sock geotextile.

When a geotextile wrapped trench is specified in the Contract Documents, wrapping of the subdrain with a knitted sock geotextile shall not be required, and the geotextile shall be installed as specified in the Contract Documents.

When OGDL or 19 mm clear stone embedment are specified in the Contract Documents, the subdrain trench and outlet pipe trench shall be wrapped with geotextile.

When granular embedment and backfill material are specified for an outlet pipe connection to a catch basin, the outlet pipe trench shall not require geotextile wrap.

405.07.05 Bedding

Bedding shall be placed in the trench to the depth specified in the Contract Documents prior to laying the subdrain or outlet pipe.

The pipe bedding grade shall be inspected with grade checks and certified by the Contractor prior to laying the subdrain or outlet pipe.

405.07.06 Laying Subdrain and Outlet Pipe

405.07.06.01 General

Pipe installation shall be according to OPSS 421 and as specified below.

The pipe shall be placed firmly on the bedding and secured in place to prevent any movement or disturbance during backfilling. Pipe with perforations on only one side shall be installed with perforations down. Pipe shall not be laid in water or on saturated bedding. Pipe shall not be used as a drain for the Contractor's operation.

Connections between the subdrain and outlet pipe shall be made with prefabricated 45° elbows or pre-manufactured pipe curves as required.

Outlet pipe shall be installed at all low lying areas, at the end of subdrain, and at a uniform spacing of 100 m along the length of the subdrain.

Subdrain and outlet pipe installation shall be inspected and approved by the Contractor prior to backfilling.

405.07.06.02 Outlets

405.07.06.02.01 General

The outlet shall have an internal diameter that is slightly larger that the outlet pipe diameter so that the outlet pipe can be inserted into the outlet a minimum distance of 300 mm.

Outlets shall extend beyond the front of the ditch or fill slope for a distance of 300 mm.

The ends of all outlets shall be fitted with galvanized rodent gates.

The joint between the outlet pipe and the outlet shall be wrapped with a 0.5 m width of geotextile.

405.07.06.02.02 Marking of Outlets

Each outlet location shall be marked with a 25 x 25 mm square galvanized steel bar, 2.2 m long, embedded from 0.6 to 1.0 m into the ground, adjacent to the outlet, clearly visible from the driving portion of the roadway.

405.07.06.03 Connection to Drainage Structures

Subdrain shall be connected to maintenance holes, catch basins, and ditch inlets by a 1 m section of non-perforated pipe. Subdrain and outlet pipe connections to concrete maintenance holes, catch basins, and ditch inlets shall be cored and grouted as specified in the Contract Documents.

405.07.07 Embedment and Backfill Material

Embedment material shall be clear stone, granular, or open graded drainage layer aggregate as specified in the Contract Documents.

Backfill material shall be as specified in the Contract Documents.

The Contractor shall ensure that the subdrain and outlet pipe are not damaged or dislodged during the placement and compaction of embedment and backfill material. Damaged or dislodged subdrain and outlet pipe shall be removed and replaced.

Any earth from cave-ins and all other unsuitable material shall be removed from embedment and backfill material.

Compaction of embedment and backfill material shall be according to OPSS 501.

At the termination of a day's work, backfilling shall be complete over all subdrain and outlet pipe placed.

405.07.07.01 Winter Grading of Material

All ice and snow shall be removed from all portions of the work area. Frozen material shall not be incorporated into the work. Material shall not be placed over frozen ground, ice or snow, except, at the Contractor's option, a single lift may be placed over frozen ground in which case final grading and compaction shall be done after the underlying materials have thawed.

405.07.08 Closed-Circuit Television Inspection

When specified in the Contract Documents, the Contractor shall inspect the drainage system using CCTV inspection to ensure that the subdrain and outlet pipes are intact and were not crushed or damaged during construction. CCTV inspection shall be according to OPSS 409.

CCTV inspection shall be based on selected sampling at locations identified by the Contract Administrator. A minimum of 5% of the entire length of subdrain pipe and 100% of the outlet pipes shall be video inspected and recorded. Where defective, damaged, or improperly installed pipe is encountered, the Contract Administrator may request additional CCTV inspection. The inspection shall be conducted following the placement of the granular course and prior to the placement of the pavement surface.

The equipment used for CCTV inspection of the drainage system shall be according to OPSS 409 with the following exceptions:

a) The system shall be capable of providing CCTV inspection of subdrain and outlet pipes of minimum 100 mm inside diameter within a wet environment and shall be capable of negotiating a minimum 45° bend.

b) The system shall be capable of inspecting a length of pipe up to 90 m by push rodding, pull cabling, jetting, or tractoring the camera through the pipe.

c) The system shall be capable of recording the distance traversed by the camera to within 150 mm.

When the CCTV inspection report shows any of the following defects, as defined by the MSCC manual, they shall be identified to the Contract Administrator and the defective, damaged, or improperly installed subdrain and outlet pipe sections shall be removed and replaced:

a) Fracture.

b) Broken.

c) Large joint displacement.

d) Large open joint.

e) Deformed pipe such that the camera is not able to navigate though the pipe.

f) Ponding water.

Replaced subdrain and outlet pipes shall be re-inspected by CCTV to verify installation.

405.07.09 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

405.08 QUALITY ASSURANCE

The Contractor shall demonstrate the outlet pipe is on grade and unobstructed for its full length after backfilling.

405.08.01 Acceptance Criteria

Acceptance of the subdrain and outlet pipes shall be installation according to the requirements of the Contract Documents and no damage or defects as defined in this specification. Subdrain and outlet pipe with damage or defects or that is improperly installed shall be removed and replaced.

405.09 MEASUREMENT FOR PAYMENT

405.09.01 Actual Measurement

405.09.01.01 Pipe Subdrain

Measurement of pipe subdrain shall be by length in metres horizontally along the centreline of the pipe between the ends of the pipe subdrain, including outlets, or between the upstream end of the pipe subdrain and the centre of a maintenance hole, catch basin, or ditch inlet.

405.09.01.02 CCTV Inspection

Measurement for a CCTV inspection of subdrain and outlet pipe shall be by length in metres on the ground surface along the centreline of the subdrain from the centre of one drainage structure to the centre of another drainage structure or the outlet end of the subdrain.

405.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

405.10 BASIS OF PAYMENT

405.10.01 Pipe Subdrain - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

When excavation and backfilling of subdrain and outlet pipe overlaps the excavation and backfilling required for other work, payment for overlapping excavation and backfilling shall be made in accordance with the specifications for such other work as though no excavation and backfilling were required for pipe subdrain.

When subdrain and outlet pipe are placed below subgrade and the embedment and backfill material are the same material used in the road base or subbase, the embedment and backfill material shall be paid for with the road base or subbase item. When embedment or backfill material or both are different than the material used for the road base or subbase, payment for the embedment and backfill material shall be included in the Contract price for the pipe subdrain.

When unstable foundations are encountered, payment for stabilization shall be as Extra Work.

Maintenance of the stability of the trench shall be at no extra cost to the Owner.

Correction of any defective workmanship and defective or damaged material shall be at no extra cost to the Owner.

405.10.02 Closed-Circuit Television Inspection - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

Re-inspection by CCTV inspection to verify the installation of replaced subdrain or outlet pipe shall be at no extra cost to the Owner.

Appendix 405-A, November 2017
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Pipe size, metal thickness, corrugation profile, and coating requirements of corrugated steel pipe. (405.05.02)

- Pipe size, type, and stiffness requirements of polyethylene and polyvinyl chloride pipe products. (405.05.03 and 405.05.04)

- The width, grade, and alignment of trench excavation. (405.07.02)

- Bedding depth. (405.07.05)

The designer should determine if the following is required and, if so, it should be specified in the Contract Documents:

- Type, Class, and Filtration Opening Size (FOS) of geotextile trench wrap. (405.05.05)

- Whether the subdrain trench and outlet are to be wrapped with geotextile. (405.07.04)

- Installation details of the geotextile trench wrap. (405.07.04)

- Material type(s) for embedment and backfill of subdrain and outlet pipes. (405.05.07 and 405.07.07)

- Tender item for the inspection of subdrain and outlet pipes by CCTV. (405.07.08 and 405.10.02)

In specifying material types for embedment material, the designer should be aware that certain granulars may have lower permeability and may not be suitable as a drainage medium.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 206.050	Subdrain Pipe Connections and Outlet Details - Rural
OPSD 207.044	Subdrain Pipe Connections and Outlets for Open Graded Drainage Layer
OPSD 216.021	Subdrain Pipe Connections and Outlet Details - Urban

CONSTRUCTION SPECIFICATION FOR NEW MAINTENANCE HOLE, CATCH BASIN, DITCH INLET, AND VALVE CHAMBER INSTALLATION

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407-A **Commentary**

407.01 SCOPE

This specification covers the requirements for the installation of maintenance holes, catch basins, ditch inlets, and valve chambers.

407.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be as specified in the Contract Documents.

407.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

407.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications shall be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 353	Concrete Curb and Gutter Systems
OPSS 402	Excavating, Backfilling, and Compacting for Maintenance Holes, Catch Basins, Ditch Inlets, and Valve Chambers
OPSS 404	Support Systems
OPSS 408	Adjusting or Rebuilding Maintenance Holes, Catch Basins, Ditch Inlets, and Valve Chambers
OPSS 490	Site Preparation for Pipelines, Utilities, and Associated Structures
OPSS 491	Preservation, Protection, and Reconstruction of Existing Facilities
OPSS 492	Site Restoration Following Installation of Pipelines, Utilities, and Associated Structures
OPSS 517	Dewatering for Excavations
OPSS 904	Concrete Structures

Ontario Provincial Standard Specifications, Material

OPSS 1004	Aggregates, Miscellaneous
OPSS 1301	Cementing Materials
OPSS 1302	Water
OPSS 1350	Concrete – Materials and Production
OPSS 1351	Precast Reinforced Concrete Components for Maintenance Holes, Catch Basins, Ditch Inlets, and Valve Chambers
OPSS 1440	Steel Reinforcement for Concrete
OPSS 1850	Frames, Grates, Covers, and Gratings
OPSS 1853	Rubber Adjustment Units for Maintenance Holes, Catch Basins, and Valve Chambers

OPSS 1854 High Density Polyethylene (HDPE) and Expanded Polystyrene (EPS) Adjustment Units for Maintenance Holes, Catch Basins, and Valve Chambers

ASTM International

C923 / C923M - 20 Resilient Connectors Between Reinforced Concrete Maintenance hole Structures, Pipes, and Laterals

407.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Adjustment Units means circular and rectangular units used between the structure and the frame to adjust the elevation of the frame for grates and covers.

Structure means cast-in-place and precast maintenance holes, catch basins, ditch inlets, and valve chambers.

407.04 DESIGN AND SUBMISSION REQUIREMENTS

407.04.01 Submission Requirements

The Contract Administrator shall be notified in writing a minimum of 10 Business Days prior to precast components for structures being delivered to the Working Area. The notification shall include:

a) Name of the company that shall be supplying the materials.

b) The schedule for the delivery of each component to the Working Area.

407.05 MATERIALS

407.05.01 Concrete

Concrete for cast-in-place structures shall be according to OPSS 1350 with a nominal minimum 28-Day compressive strength of 30 MPa.

407.05.02 Steel Reinforcement

Steel bar reinforcement, bar mats, and wire fabric for cast-in-place structures shall be according to OPSS 1440.

407.05.03 Precast Concrete Components for Maintenance Holes, Catch Basins, Ditch Inlets, and Valve Chambers

Precast units shall be according to OPSS 1351 and as specified in the Contract Documents.

407.05.04 Steps and Ladders

Steps shall be according to OPSS 1351 and as specified in the Contract Documents.

Ladders shall be as specified in the Contract Documents.

407.05.05 Adjustment Units

Precast concrete adjustment units shall be according to OPSS 1351.

Rubber adjustment units shall be according to OPSS 1853.

High density polyethylene (HDPE) and expanded polystyrene (EPS) adjustment units shall be according to OPSS 1854.

407.05.06 Mortar and Grout

Mortar shall consist of a mixture of one part Portland cement according to OPSS 1301 and three parts mortar sand according to OPSS 1004, wetted with sufficient water to make the mixture plastic.

Grout shall consist of a mixture of one part Portland cement according to OPSS 1301 and two parts mortar sand according to OPSS 1004, wetted with sufficient water to make the mixture plastic.

Water for mortar and grout shall be according to OPSS 1302.

407.05.07 Frames with Covers or Grates

Frames with covers or grates shall be according to OPSS 1850 and as specified in the Contract Documents.

407.05.08 Aluminum Safety Platforms

Aluminum safety platforms shall be according to OPSS 1351 and as specified in the Contract Documents.

407.05.09 Joint Seal Systems

Joint seal systems for precast concrete structures shall be according to OPSS 1351.

407.05.10 Resilient Connectors

Resilient connectors between pipes and structures shall be according to ASTM C923M.

407.07 CONSTRUCTION

407.07.01 General

Structures shall be constructed plumb and true to alignment and shall be installed on undisturbed and competent foundations at the locations and to the elevations as specified in the Contract Documents.

The top of structures shall be installed below the final grade to allow for the placement of adjustment units to facilitate the placement of the top of the frame with grate or cover to the final grade.

407.07.02 Operational Constraints

Precast concrete maintenance hole tees may be used only when the mainline pipe sewer is concrete.

Precast concrete maintenance hole tees shall not be used when a change in pipe size, longitudinal grade, or direction is required.

All work shall be protected from freezing. Structures shall not be installed on frozen ground.

Damage to structures due to floatation shall be prevented during construction and until Completion.

407.07.03 Site Preparation

Site preparation shall be according to OPSS 490.

407.07.04 Preservation and Protection of Existing Facilities

Preservation and protection of existing facilities shall be according to OPSS 491.

407.07.05 Transporting, Unloading, Storing, and Handling

Manufacturer recommendations for transporting, unloading, storing, and handling of structures shall be followed.

Materials that are unsound or damaged shall be rejected.

407.07.06 Excavating, Backfilling, and Compacting

Excavating, backfilling, and compacting for the installation of structures shall be according to OPSS 402.

407.07.07 Support Systems

Support systems shall be according to OPSS 404.

407.07.08 Dewatering

Dewatering shall be according to OPSS 517.

407.07.09 Cast-In-Place Structures

Concrete placement shall be according to OPSS 904.

All inside wall projections, such as fins and bulges, shall be removed once the forms are stripped.

407.07.10 Precast Structures

Precast or mono bases shall be placed level. Subsequent sections complete with joint seal systems shall be installed according to the manufacturer's recommendations. Joint seal systems for special site conditions (infiltration/exfiltration) shall be as specified in the Contract Documents.

Adjustment of the structure shall be carried out by lifting the affected sections free of the excavation, re-levelling the base, if necessary, and re-installing the sections. Damaged sections and gaskets shall be replaced.

Lift holes shall be plugged with mortar.

407.07.11 Installation of Inlet and Outlet Pipes into Concrete Structures

To accommodate inlet and outlet pipe installation into the concrete structure, the appropriate size opening in the wall shall be constructed as specified in the Contract Documents.

Inlet and outlet pipes shall be securely set into the concrete structure's concrete base or walls using grout or approved pipe connectors so that the structure is watertight.

One of the following connections shall be provided where a pipe connects to a structure:

a) A flexible pipe joint shall be provided within 300 mm of the outside face of the structure for flexible and rigid pipe.

b) A concrete cradle to the first joint for rigid pipe.

c) A resilient connector (i.e., a flexible, watertight connector) in the structure opening for flexible and rigid pipe.

d) A special approved structure designed for pipe support.

e) An external joint sealing product according to OPSS 1351.

Installation of pipe connectors shall be according to the manufacturer's recommendations. All pipes, except in valve chambers, shall be flush with the inside walls of the structure.

When specified in the Contract Documents, a goss trap shall be placed at the outlet pipe of the catch basin.

When a subdrain is specified in the Contract Documents, the opening for the connection of the subdrain outlet shall be formed by coring. The subdrain outlet pipe shall be sealed into place using non-shrink grout. A 50 mm diameter weep hole shall be cored into the same wall as the subdrain connection and at the same invert elevation.

407.07.12 Benching and Channelling

When specified in the Contract Documents, the inside concrete bottom of the structures shall be benched and channeled to accommodate the pipe.

Where benching is hand finished, it shall have a wood float finish and channelling shall have a steel trowel finish. Channelling shall be smooth and flush with adjacent pipe inverts.

407.07.13 Installation of Adjustment Units

Installation of adjustment units shall be according to OPSS 408.

407.07.14 Installation of Frames with Grates or Covers

When precast concrete adjustment units are used, frames with grates or covers shall be set in a full bed of mortar on the precast concrete adjustment units.

When HDPE or EPS adjustment units are used, frames with grates or covers shall be installed and sealed according to the HDPE or EPS adjustment unit manufacturer’s instructions.

When rubber adjustment units are used, frames with grates or covers shall be set firmly in place on the rubber adjustment unit by laying a continuous strip of butyl tape on the top surface of the rubber adjustment units and on the bottom of the frame.

Ditch inlet grates shall be installed as specified in the Contract Documents.

Installation of frames with grates or covers which lie within the flow lines of a curb and gutter system shall be according to OPSS 353.

407.07.15 Installation of Aluminum Safety Platforms

Aluminum safety platforms shall be installed as specified in the Contract Documents.

407.07.16 Installation of Extension Stems and Boxes for Valve Chambers

Extension stems and boxes shall be installed as specified in the Contract Documents.

Caps for valve boxes shall be installed flush with the final grade. Guides for the valve extension stems shall be securely anchored to the valve chamber.

407.07.17 Installation of Ladders and Steps

Ladders shall be installed as specified in the Contract Documents.

If the structure is being cast-in-place, steps shall be accurately set in the forms and supported to prevent their displacement during the placing of concrete.

407.07.18 Installation of Frost Straps

Frost straps shall be installed as specified in the Contract Documents.

407.07.19 Valve Chamber Insulation

Insulation for the roof, wall, or access way of the valve chamber shall be installed as specified in the Contract Documents.

407.07.20 Clean Out of Structures

During the progress of the work and until Completion, structures shall be kept clean and free of all foreign material.

407.07.21 Site Restoration

Site restoration shall be according to OPSS 492.

407.07.22 Leakage Test

Maintenance holes shall be tested for leakage when specified in the Contract Documents. Leakage shall not exceed a rate of 3 litres per hour per metre of head above the lowest pipe invert in the maintenance hole.

The test shall be performed by plugging all pipe openings in the maintenance hole and filling the maintenance hole with water. After 1 hour has elapsed, the distance the surface of the water has dropped shall be measured and the leakage determined by calculating the volume of that portion of the maintenance hole formerly occupied by the water.

Maintenance holes failing the initial test shall have the leaks repaired and be re-tested until the leakage is below the allowable limit.

There shall be no visible infiltration.

407.07.23 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

407.09 MEASUREMENT FOR PAYMENT

407.09.01 Actual Measurement

407.09.01.01 Maintenance Hole
Catch Basin
Ditch Inlet
Valve Chamber

For measurement purposes, a count shall be made of the number of structures installed.

407.09.01.02 Maintenance Hole Leakage Testing

For measurement purposes, a count shall be made of the number of maintenance holes passing the leakage test.

407.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

407.10 BASIS OF PAYMENT

407.10.01 Maintenance Holes, "type, size" - Item
Catch Basins "type, size" - Item
Ditch Inlets "size" - Item
Valve Chambers "size" - Item
Maintenance Hole Leakage Testing - Item
Maintenance Hole Leakage Testing - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

407.10.02 Elevation Adjustment

Prior to the installation of a structure, the Owner may, at its sole discretion, raise or lower the invert or grate elevation by 150 mm or less, at no additional cost. Bedding elevations shall be adjusted accordingly.

A change in invert or grate elevation exceeding 150 mm shall be administered as a Change in the Work.

407.10.03 Adjusting or Rebuilding Maintenance Holes, Catch Basins, and Ditch Inlets

Payment for adjusting or rebuilding maintenance holes, catch basins, and ditch inlets shall be according to OPSS 408.

Appendix 407-A, November 2021
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer may consider including soil boring data, a geotechnical report, a subsurface report, and/or a soils report in the Contract Documents.

The designer should specify the following in the Contract Documents:

- Minimum Working Days. (407.04.01)

- Material requirements for:
  - Precast units. (407.05.03)
  - Steps and ladders. (407 05.04)
  - Frames with covers or grates. (407.05.07)
  - Aluminum safety platforms. (407.05.08)

- Structure type, location, and elevation. (407.07.01)

- Precast Structures. (407.07.10)

- Inlet and outlet pipe installation into concrete structure. (407.07.11)

- Goss trap and subdrains. (407.07.11)

- Type and location of goss traps. (407.07.11)

- Joint seal systems for special site conditions. (407.07.12)

- Benching and channeling. (407.07.12)

- Installation of:
  - Ditch inlet grates. (407.07.14)
  - Aluminum safety platforms. (407.07.15)
  - Extension stems and boxes. (407.07.16)
  - Ladders and steps. (407.07.17)
  - Frost straps. (407.07.18)
  - Valve chamber insulation. (407.07.19)

- Sanitary sewer maintenance holes and storm sewer maintenance holes leakage test(s). (407.07.22)

- Adjusting or rebuilding maintenance holes, catch basins, and ditch inlets. (407.10.03)

The Contractor may use any of the connections shown in subsection 407.07.13 d). If a specific connection is required, it shall be specified in the Contract Documents.

Designer should determine if leakage testing for storm and sanitary sewer maintenance holes is required. If it is required, it shall be specified in the Contract Documents. Ground water conditions shall determine

the type of test required and shall be specified in the Contract Documents. Alternative leakage test method(s) can be considered such as air or CCTV inspection. (407.07.25)

The tender item description for Maintenance Holes, Catch Basins, Ditch Inlets, and Valve Chambers should include reference to one or more of the attributes shown (i.e., type of structure or size of structure, to be complete). (407.10.01)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 400.001	Hoisting Hook Rib for Cast Iron Frames for Catch Basins, Maintenance Holes, and Valve Chambers
OPSD 400.010 to 400.120	Cast Iron Catch Basin Frames with Grates
OPSD 401.010 to 401.060	Cast Iron Maintenance Hole Frames with Covers
OPSD 402.010 to 402.021	Cast Iron Valve Chamber Frames with Covers
OPSD 403.010	Galvanized Steel Honey Comb Grating for Ditch Inlets
OPSD 404.010 to 404.022	Aluminum Safety Platforms
OPSD 405.010 to 405.020	Maintenance Hole Steps
OPSD 610.010 to 610.030	Catch Basin Frame with Grate Installation
OPSD 701.010 to 701.015	Precast Concrete Maintenance Holes, 1,200 to 3,600 mm in Diameter
OPSD 701.021	Maintenance Hole Benching and Pipe Opening Details
OPSD 701.030 to 701.081	Precast Concrete Maintenance Hole Components, 1,200 to 3,600 mm in Diameter
OPSD 701.100	Frost Strap Installation
OPSD 702.040 to 702.050	Precast Concrete Ditch Inlet Maintenance Hole
OPSD 703.011 to 703.015	Precast Concrete Single Inlet Flat Cap, 1,500 to 3,600 mm in Diameter
OPSD 703.021 to 703.024	Precast Concrete Twin Inlet Flat Cap, 1,500 to 3,000 mm in Diameter
OPSD 704.010 to 704.012	Maintenance Hole, Catch Basin, and Valve Chamber Adjustment Units
OPSD 705.010 to 705.020	Precast Concrete Catch Basins
OPSD 705.030 to 705.040	Precast Concrete Ditch Inlets
OPSD 706.010 to 706.041	Precast Concrete Ditch Inlets Types A and B with 1,500 to 3,000 mm Diameter Flat Cap
OPSD 707.010	Precast Maintenance Hole Manufactured Tee
OPSD 708.020	Support for Pipe at Catch Basin or Maintenance Hole
OPSD 1100.010	Cast-In-Place Chamber for Valves Up to 350 mm Diameter
OPSD 1101.010	Precast Valve Chamber 1,200 mm and 1,500 mm Diameter
OPSD 1101.020	Valve Operator

CONSTRUCTION SPECIFICATION FOR ADJUSTING OR REBUILDING MAINTENANCE HOLES, CATCH BASINS, DITCH INLETS, AND VALVE CHAMBERS

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APPENDICES

408-A **Commentary**

408.01 SCOPE

This specification covers the requirements for adjusting or rebuilding maintenance holes, catch basins, ditch inlets, valve chambers and the installation of safety platforms.

408.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be as specified in the Contract Documents.

408.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

408.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 353	Concrete Curb and Gutter Systems
OPSS 402	Excavating, Backfilling, and Compacting for Maintenance Holes, Catch Basins, Ditch Inlets, and Valve Chambers
OPSS 404	Support Systems
OPSS 407	Maintenance Hole, Catch Basis, Ditch Inlet, and Valve Chamber Installation
OPSS 490	Site Preparation for Pipelines, Utilities, and Associated Structures
OPSS 491	Preservation, Protection, and Reconstruction of Existing Facilities
OPSS 492	Site Restoration Following Installation of Pipelines, Utilities, and Associated Structures
OPSS 510	Removal
OPSS 904	Concrete Structures
OPSS 920	Deck Joint Assemblies, Preformed Seals, Joint Fillers, Joint Seals, Joint Sealing Compounds, and Waterstops - Structures

Ontario Provincial Standard Specifications, Material

OPSS 1004	Aggregates - Miscellaneous
OPSS 1301	Cementing Materials
OPSS 1302	Water
OPSS 1350	Concrete - Materials and Production
OPSS 1351	Precast Reinforced Concrete Components for Maintenance Holes, Catch Basins, Ditch Inlets, and Valve Chambers
OPSS 1440	Steel Reinforcement for Concrete
OPSS 1850	Frames, Grates, Covers, and Gratings
OPSS 1853	Rubber Adjustment Units for Maintenance Holes, Catch Basins, and Valve Chambers

OPSS 1854 High Density Polyethylene (HDPE) and Expanded Polystyrene (EPS) Adjustment Units for Maintenance Holes, Catch Basins, Ditch Inlets, and Valve Chambers

408.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Adjusting means changing the final grade or position of the frame with cover or grate on an existing structure:

a) upwards by the addition of adjustment units;

b) downwards by removal of existing adjustment units or bricks and mortar, regardless of the size or type of structure; or

c) lateral deviation from centreline.

Adjustment Units means circular and rectangular units used between the structure and the frame to adjust the elevation of the frame for grates and covers.

Lift Rings means circular and rectangular pre-fabricated metal or high density polyethylene units used to adjust the elevation of the grates and covers only. They are inserted between the frame and the grate or cover.

Rebuilding means changing the final grade of the frame with grate or cover on an existing structure:

a) upwards by the addition of precast concrete sections, concrete, and adjustment units; or

b) downwards by the removal of precast concrete sections, concrete, and adjustment units or bricks and mortar, regardless of the size or type of structure.

Structure means cast-in-place and precast maintenance holes, catch basins, ditch inlets, and valve chambers.

408.05 MATERIALS

408.05.01 Concrete

Concrete for cast-in-place structures shall be according to OPSS 1350 with a minimum 28-Day compressive strength of 30 MPa.

408.05.02 Steel Reinforcement

Steel bar reinforcement, bar mats, and wire fabric for cast-in-place structures shall be according to OPSS 1440.

408.05.03 Precast Concrete Components for Maintenance Holes, Catch Basins, Ditch Inlets, and Valve Chambers

Precast units shall be according to OPSS 1351 and as specified in the Contract Documents.

408.05.04 Steps and Ladders

Steps shall be according to OPSS 1351 and as specified in the Contract Documents. Ladders shall be as specified in the Contract Documents.

408.05.05 Adjustment Units

Precast concrete adjustment units shall be according to OPSS 1351.

Rubber adjustment units shall be according to OPSS 1853.

High density polyethylene (HDPE) and expanded polystyrene (EPS) adjustment units shall be according to OPSS 1854.

408.05.06 Mortar

Mortar shall consist of a mixture of one part Portland cement according to OPSS 1301 and three parts mortar sand according to OPSS 1004, wetted with sufficient water to make the mixture plastic. Water shall be according to OPSS 1302.

408.05.07 Frames with Covers or Grates, and Lift Rings

Frames with covers or grates, and lift rings shall be according to OPSS 1850.

408.05.08 Aluminum Safety Platforms

Aluminum safety platforms shall be according to OPSS 1351 and as specified in the Contract Documents.

408.05.09 Joint Seal Systems

Joint seal systems for precast concrete structures shall be according to OPSS 1351.

408.07 CONSTRUCTION

408.07.01 General

The work of adjusting or rebuilding structures shall include the removal and subsequent replacement of the frame with grate or cover.

All structures shall be adjusted or rebuilt plumb, true to alignment and grade, and as specified in the Contract Documents.

During the progress of the Work and until Completion, all structures in service shall be kept clean and free of all extraneous material.

Prior to adjusting or rebuilding a structure, the existing frame with cover or grate shall be carefully removed and salvaged according to OPSS 510. Suitability of the salvaged frame with cover or grate for reuse shall be determined by the Contract Administrator.

The installation and subsequent removal of a temporary one-piece frame and grate to the maintenance holes or catch basins during construction staging shall be at location(s) as specified in the Contract Documents. The installation of frame and grate shall be according to OPSS 407. The one-piece frame and grate shall be removed according to OPSS 510 when it is no longer required. The original frame and grate shall be put back into place after the one-piece frame and grate is removed. The one-piece frames and grates shall be installed prior to opening the detour to traffic.

The installation of adjustment units, frames, covers, grates, lift rings, precast concrete components, and joint seal systems shall be according to OPSS 407 and as specified in the Contract Documents.

Additional steps or ladder extensions are required when the distance from the adjusted cover or grate reference elevation to the first step exceeds 450 mm. Additional steps shall be placed according to OPSS 1351.

Alterations to ladders, valve extension stems and boxes, and frost straps shall be as specified in the Contract Documents.

After having been raised, any structure that has a total height of 5.0 m or more shall have a safety platform installed in it. The aluminum safety platforms shall be installed as specified in the Contract Documents.

After adjusting or rebuilding a valve chamber, insulation shall be installed according to the manufacturer's recommendations on the roof, wall, or access way of the valve chamber, when specified in the Contract Documents.

408.07.02 Site Preparation

Site preparation shall be according to OPSS 490.

408.07.03 Preservation and Protection of Existing Facilities

Preservation and protection of existing facilities shall be according to OPSS 491.

408.07.04 Cold Weather Work

All work shall be protected from freezing.

408.07.05 Transporting, Unloading, and Storing and Handling

Transporting, unloading, storing, and handling shall be according to manufacturer's recommendations. Materials that are unsound or damaged shall be rejected.

408.07.06 Excavating, Backfilling, and Compacting

Excavating, backfilling, and compacting for the adjustment or rebuilding of structures shall be according to OPSS 402.

408.07.07 Support Systems

Support systems shall be according to OPSS 404.

408.07.08 Adjusting

All existing brickwork and mortar shall be removed from the top of the existing structure.

When there are adjustment units on an existing structure, adjustment units shall be added or removed as required so when the adjustment is completed there is a minimum of one to a maximum of three adjustment units on the top of the structure prior to placing the frame with grate or cover.

The maximum allowable total lateral deviation of catch basin covers and grates from the centreline of the structure is 75 mm.

408.07.08.01 Precast Concrete Adjustment Units

Precast concrete adjustment units shall be used to set the frame with grate or cover at the required position and elevation.

A minimum of one adjustment unit, but not more than three adjustment units are required at each structure to a maximum height of 300 mm.

The first adjustment unit shall be laid in a full bed of mortar and aligned with the opening in the structure. Successive adjustment units shall be laid plumb to the first adjustment unit and sealed according to manufacturer's recommendations.

408.07.08.02 High Density Polyethylene (HDPE) and Expanded Polystyrene (EPS) Adjustment Units

When specified in the Contract Documents, HDPE or EPS adjustment units shall be used to set the frame with grate or cover at the required position and elevation.

A minimum of one adjustment unit is required at each structure up to a maximum height of 100 mm.

HDPE or EPS adjustment units shall be installed and sealed according to the manufacturer’s recommendations.

Rubber adjustment units shall not be used in conjunction with HDPE or EPS adjustment units.

408.07.08.03 Rubber Adjustment Units

Rubber adjustment units shall be used when specified in the Contract Documents. One rubber adjustment unit is used to replace the top precast concrete adjustment unit per structure and shall be used in conjunction with one or two precast concrete adjustment units. More than one rubber adjustment unit may be placed when wedge shaped rubber units are used to provide slope to the frame with grate or cover. In either instance, the total height of the rubber units shall be greater than 25 mm and less than 75 mm. The rubber unit is to be placed on the precast concrete adjustment unit so it provides the surface on which the frame rests.

The rubber adjustment unit shall be bonded firmly in place on the precast concrete adjustment unit by laying a continuous strip of butyl tape on the top surface of the precast concrete unit. If more than one rubber unit is used, a continuous strip of butyl tape shall be laid between each rubber adjustment unit.

408.07.09 Rebuilding

408.07.09.01 General

All existing brickwork and mortar or adjustment units shall be removed from the top of the existing structure.

The completed rebuilt structure shall have a minimum of one to a maximum of three adjustment units on the top of the structure prior to placing the frame with grate or cover.

408.07.09.02 Cast-In-Place Structures

When the top of the structure is to be lowered, the concrete shall be carefully removed to the required elevation and exposed steel reinforcement shall be cut off as specified in the Contract Documents. The upper section of the structure shall then be rebuilt to its original configuration using cast-in-place concrete and steel reinforcement as specified in the Contract Documents.

To raise the top of structures with a tapered upper section, the concrete in the structure shall be removed for the entire depth of the taper. The upper section, including straight walls and taper shall then be rebuilt to the original configuration using cast-in-place concrete and steel reinforcement as specified in the Contract Documents.

To raise the top of straight walled structures, the existing roof section, if any, shall be removed. The existing walls shall then be extended upward and the roof section rebuilt to the original configuration using cast-in-place concrete and steel reinforcement as specified in the Contract Documents.

When cast-in-place units are to be raised or lowered with cast-in-place concrete, the top surface of all existing walls shall be roughened and a bonding agent shall be applied to the joint before the walls are extended upwards.

Concrete shall be placed according to OPSS 904.

All inside wall projections, such as fins and bulges, shall be removed once the forms are stripped.

408.07.09.03 Precast Concrete Structures

Where precast concrete structures having either a tapered or flat slab top section are to be raised or lowered, the top section shall be carefully removed and salvaged and riser sections of suitable height shall be carefully removed from, substituted for, or added to the existing riser sections.

The procedure described for lowering a cast-in-place structure shall be followed as an alternative to the method described above for lowering a precast structure.

408.07.09.04 Catch Basin Apron

Curb and gutter with concrete aprons on existing catch basins shall be constructed at the locations as specified in the Contract Documents.

The work shall include, but not be limited to, the following:

a) Remove existing curb and gutter and existing pavement by saw cutting to the limits shown in the Contract Documents.

b) Construction of concrete curb and gutter shall be according to OPSS 353.

c) Placement of concrete for concrete apron shall be according to OPSS 353.

d) Concrete for curb and gutter and apron shall be poured in place as one structure.

e) Placement of joint sealing compound and joint filler in construction joints shall be according to OPSS 920.

f) The horizontal limits of the concrete apron to fit local conditions.

408.07.09.05 Breaking into Maintenance Holes, Catch Basins, Ditch Inlets, Culverts and Sewers

To accommodate inlet and outlet pipe installation into existing or rebuilt structures, the appropriate size opening in the wall shall be constructed as specified in the Contract Documents.

408.07.10 Site Restoration

Site restoration shall be according to OPSS 492.

408.07.11 Maintenance Hole Leakage Testing

Sanitary sewer maintenance holes and storm sewer maintenance holes shall be tested for leakage according to OPSS 407.

408.07.12 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

408.09 MEASUREMENT FOR PAYMENT

408.09.01 Actual Measurement

408.09.01.01 Adjusting Maintenance Holes - Item
Rebuilding Maintenance Holes - Item
Adjusting Catch Basins - Item
Rebuilding Catch Basins - Item
Adjusting Ditch Inlets - Item
Rebuilding Ditch Inlets - Item
Installation of Lift Rings - Item
Adjusting Valve Chambers - Item
Rebuilding Valve Chambers - Item
Rebuilding Catch Basin Apron – Item
Temporary One-piece Frame and Grate - Item

For measurement purposes, a count shall be made of the number of structures adjusted or rebuilt.

408.09.01.02 Breaking into Maintenance holes, Catch Basins, Ditch Inlets, Culverts and Sewers

For measurement purposes, a count shall be made of the number of openings made.

408.09.01.03 Interim Adjustments of New Structures

For interim adjustments of new maintenance holes, catch basins and ditch inlets due to staging, winter maintenance or other requirements of a new construction, a count shall be made of each adjustment.

408.09.01.04 Installation of Safety Platforms

For measurement purposes, a count shall be made of the number of safety platforms installed.

408.09.01.05 Temporary One-piece Frame and Grate

For measurement purposes, a count shall be made of the number of temporary one-piece frame and grate installed.

408.09.01.06 Installation of Lift Rings

For measurement purposes, a count shall be made of the number of lift rings installed.

408.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

408.10 BASIS OF PAYMENT

408.10.01 Adjusting Maintenance Holes - Item
Rebuilding Maintenance Holes - Item
Adjusting Catch Basins - Item
Rebuilding Catch Basins - Item
Adjusting Ditch Inlets - Item
Rebuilding Ditch Inlets – Item
Installation of Lift Rings - Item
Adjusting Valve Chambers - Item
Rebuilding Valve Chambers - Item
Installation of Safety Platforms - Item
Rebuilding Catch Basin Apron – Item
Temporary One-piece Frame and Grate – Item
Breaking into Maintenance holes, Catch Basins, Ditch Inlets, Culverts and Sewers - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

408.10.02 Maintenance Hole Leakage Testing

Payment for maintenance hole leakage testing shall be according to OPSS 407.

Appendix 408-A, November 2021
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Material requirements for:
  - Precast units. (408.05.03)
  - Steps and ladders. (408.05.04)
  - Aluminum safety platforms. (408.05.08)

- Adjustment and rebuilding requirements. (408.07.01)

- Installation of:
  - Aluminium safety platforms. (408.07.01)
  - Valve chamber insulation. (408.07.01)

- Locations, types, installation and subsequent removal of a temporary one-piece frame and grate to the maintenance holes or catch basins during construction staging. (408.07.01)

- Types of adjustment units, frames, covers, grates, lift rings, precast concrete components, and cast-in-place aprons, and joint seal systems. (408.07.01)

- Alterations to ladders, valve extension stems and boxes, and frost straps. (408.07.01)

- Installation of aluminum safety platforms. (408.07.01)

- Insulation. (408.07.01)

- Use of HDPE or EPS adjustment units. (407.07.08.02)

- Rubber adjustment units. (407.07.08.03)

- Additional adjustments required. (408.09.01.02)

- Cut-off of exposed steel reinforcement. (408.07.09.02)

- Concrete and steel placement requirements. (408.07.09.02)

- Catch Basin Apron. (408.07.09.04)

- Breaking into maintenance holes, catch basins, ditch inlets, culverts and sewers. (408.07.09.04)

The designer should consider determining the number of salvageable frames with covers or grates. If there are frames with covers or grates that are not suitable for salvage, then an item should be added to the Contract Documents to ensure there are a sufficient number of new frames with covers or grates to fill the Contract needs.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 400.001	Hoisting Hook Rib for Cast Iron Frames for Catch Basins, Maintenance Holes, and Valve Chambers
OPSD 400.010 to 400.120	Cast Iron Catch Basin Frames With Grates
OPSD 401.010 to 401.060	Cast Iron Maintenance Hole Frames With Covers
OPSD 402.010 to 402.021	Cast Iron Valve Chamber Frames With Covers
OPSD 403.010	Galvanized Steel Honey Comb Grating for Ditch Inlets
OPSD 404.020 to 404.022	Aluminum Safety Platforms
OPSD 405.010 to 405.020	Maintenance Hole Steps
OPSD 406.010	Aluminum Ladder for maintenance Holes
OPSD 610.010 to 610.030	Catch Basin Frame With Grate Installation
OPSD 701.010 to 701.015	Precast Concrete Maintenance Holes, 1,200 to 3,600 mm in Diameter
OPSD 701.030 to 701.081	Precast Concrete Maintenance Hole Components, 1,200 to 3,600 mm in Diameter
OPSD 701.100	Frost Strap Installation
OPSD 702.040 to 702.050	Precast Concrete Ditch Inlet Maintenance Hole
OPSD 703.011 to 703.015	Precast Concrete Single Inlet Flat Cap, 1,500 to 3,600 mm in Diameter
OPSD 703.021 to 703.024	Precast Concrete Twin Inlet Flat Cap, 1,500 to 3,000 mm in Diameter
OPSD 704.010 to 704.012	Maintenance Hole, Catch Basin, and Valve Chamber Adjustment Units
OPSD 705.001 to 705.002	Concrete Catch Basin Apron
OPSD 705.010 to 705.020	Precast Concrete Catch Basins
OPSD 705.030 to 705.040	Precast Concrete Ditch Inlets
OPSD 706.010 to 706.041	Precast Concrete Ditch Inlets Types A and B with 1,500 to 3,000 mm Diameter Flat Cap
OPSD 1100.010	Cast-In-Place Chamber for Valves Up to 350 mm Diameter
OPSD 1101.010	Precast Valve Chamber 1,200 mm and 1,500 mm Diameter
OPSD 1101.020	Valve Operator

CONSTRUCTION SPECIFICATION FOR CLOSED-CIRCUIT TELEVISION (CCTV) INSPECTION OF PIPELINES

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APPENDICES

409-A **Commentary**

409.01 SCOPE

This specification covers the requirements for inspecting new and existing pipelines, which include storm and sanitary sewers, watermains, pipe culverts or other accessible conduits by closed-circuit television (CCTV).

409.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be as specified in the Contract Documents.

409.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

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409.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

CSA Standards

PLUS 4012 (2010) Technical Guide: Visual Inspection of Sewer Pipe

Water Research Centre (WRc) Publication

MSCC, Manual of Sewer Condition Classification, 4th Edition, December 2003

Canadian Standards Association

Pipeline Assessment and Certification Program (PACP®) Canadian Edition including CSA PLUS 4012 TECHNICAL GUIDE Visual inspection of sewer pipe;

409.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Business Day means any day except Saturdays, Sundays, and statutory holidays.

CCTV means closed-circuit television.

Digital Storage Device means compact disc (CD), digital videodisc (DVD), flash memory card, hard drive, or other industry-standard digital storage mediums.

Drainage Structure means a catch basin, maintenance hole, or ditch inlet.

DVD means digital videodisc.

MPEG means movie photographic experts group.

NASSCO means North American Society of Sewer Service Companies.

PACP means Pipeline Assessment and Certification Program.

Pipeline means storm, sanitary, watermains, pipe culverts or other accessible pipe conduits.

USB means universal serial bus.

409.04 DESIGN AND SUBMISSION REQUIREMENTS

409.04.01 Submission Requirements

The following information shall be submitted to the Contract Administrator two weeks prior to the start of the CCTV inspection operations:

a) A copy of the CCTV operator's NASSCO Certification Certificate. A copy of said certificate is required for each CCTV operator working on the Contract. Operators shall have been certified or re-certified within the three years prior to the start of the Contract.

b) A sample inspection report and video recording.

c) resolution tests of digital video recording format, and digital data file. One submission is required for each camera proposed for use on the work. The camera make, model, and serial number shall be clearly identified on each video recording.

d) The details of the coding accuracy verification system that is to be used to verify inspection accuracy.

409.05 MATERIALS

409.05.01 General

Media storage shall be as specified in the Contract Documents.

Digital storage device with minimum USB 2.0 or higher compatibility shall be placed inside envelopes with labels displaying the following information.

a) Owner’s Name

b) Contract Number or Project Name

c) Sewer Identification Number

d) Region or Municipality

e) Street Name, Park Name or Highway Number

f) Inspection Date

The digital storage device shall include a file in either Word or text format including the information provided above. The digital storage device shall be labelled. The label shall include the information in points a) and b) above to identify the content. CD and DVD shall be placed in a 5.2 mm slim-line clear jewel case with permanent labels displaying all the information above or as specified in the Contract Documents.

409.05.01.01 Photographs

Digital photograph files shall meet or exceed a resolution of at least 640 x 480 pixels, and be in JPEG format or as specified in the Contract Documents. Printed photographs shall be in colour with a minimum image size of 90 x 70 mm and shall be reproduced on premium glossy photo quality paper.

409.06 EQUIPMENT

409.06.01 General

Inspection and camera equipment used to inspect watermains shall have been used exclusively for work in watermains only.

409.06.02 Inspection Vehicle

The inspection vehicle shall contain a separate area for viewing, recording, and controlling the CCTV operation.

The viewing and control area shall be insulated against noise and extremes in temperature. Cooling and heating units shall be independent from the main vehicle engine and in good working order. External and internal sources of light shall be controlled in a manner as to ensure the light does not impede the view of the monitor screen. Seating accommodation for one person shall be provided in addition to the operator seating to clearly view the monitor screen.

All equipment used within the pipeline shall be stored outside the viewing, recording, and control area.

The vehicle shall include a cell phone or suitable alternative as agreed by the Contract Administrator for the duration of the work.

409.06.03 Inspection Equipment

The inspecting equipment shall be capable of inspecting a length of pipeline up to:

a) 300 m when entry to the pipeline may be obtained at each end of the pipeline.

b) 30 m when rodding is used.

c) 150 m when a self-propelled unit is used when entry is at only one end of the pipeline.

d) 200 m when being towed.

Work shall not commence in a work shift until the Contract Administrator is satisfied that all items of the inspection equipment have been provided and are in full working order.

Each inspection unit shall contain a means of transporting the CCTV camera in a stable condition through the pipeline.

When the CCTV camera is towed by winch and cable through the pipeline, all winches shall be stable during the entire CCTV inspection. All cables shall be of steel or of an equally non-elastic material to ensure the smooth and steady progress of the CCTV camera.

Each unit shall carry sufficient number of guides and rollers so that, when inspecting, all cables are supported away from pipe and maintenance hole edges. All CCTV cables and lines used to measure the camera's location within the pipeline shall be maintained in a taut manner and set at right angles, when possible, to run through or over the measuring equipment.

409.06.04 Video Equipment Quality

The electronic systems, television camera, and monitor shall be of such quality to enable the following to be achieved.

409.06.04.01 Camera

The pan and tilt camera shall have the capability of panning the pipe at 360° with tilt capability of 275° to ensure complete inspections and view of all laterals and deficiencies.

Resolution:

The live picture shall be visible with no interference and capable of registering a minimum number of lines of resolution at the periphery as indicated below:

a) Fixed view camera 350 lines of resolution, or.

b) Pan and tilt camera 400 lines of resolution.

Colour Constancy:

The lighting shall be set prior to commencing the inspection to ensure the camera provides optimum results when used with its own illumination source. To ensure colour constancy, no variation in illumination shall take place during the inspection.

Focus, Iris, and Illumination:

The adjustment of focus and iris shall allow optimum picture quality to be achieved and shall be remotely operated. The illumination shall be such as to allow an even distribution of the light around the pipeline perimeter without the loss of contrast or flare out of picture shadowing.

409.06.04.02 Monitor

Monitors shall support resolution equal to or greater than the corresponding video camera resolution.

409.06.04.03 Digital Video Recorder

Digital video recorders shall be able to capture in colour from the live video source with the following requirements:

a) MPEG-2 or higher or as required by Owner.

b) NTSC 720 x 480 @ 29.97 frames per second.

c) Data/Bit Rate: MPEG-1 @ 2.4 M-bits/sec.

409.07 CONSTRUCTION

409.07.01 Pipeline Cleaning

When specified in the Contract Documents, pipelines shall be cleaned and flushed immediately prior to CCTV inspection.

409.07.02 Resolution of Videotape and Digital MPEG Video Recordings

Prior to the start of the CCTV inspection, the resolution of digital MPEG video playback for each camera shall be confirmed by recording a resolution chart approved by the Contract Administrator, using the following procedure:

a) Set up the camera as is done for the actual inspection.

b) Show the camera being introduced and reaching its final position for the test.

c) Fill the monitoring screen with the resolution chart.

d) Illuminate the resolution chart evenly and uniformly without reflections ensuring that the illumination source accurately simulates the lighting used in the sewer.

e) Record a test video for 30 seconds.

f) Identify the camera make, model, and serial number on the recording.

g) Record the test at the start of a digital recording.

The resolution test shall be submitted to the Contract Administrator.

409.07.03 Coding Accuracy

Prior to commencement of the CCTV inspection, a formal coding accuracy verification system, based on accuracy as a function of the number of defects or construction features not recorded and the correctness of the coding and classification recorded, shall be developed, submitted to the Contract Administrator, and implemented when approved.

Verification of coding accuracy shall be completed on a random basis on a minimum of 10% of the inspection reports or one per video, whichever is greater. A minimum of two accuracy verifications shall be done for each operator for each week working.

Inspections not satisfying the accuracy requirements shall be re-coded to meet the accuracy requirements and the accuracy of the inspections, immediately preceding and following the non-compliant inspection, shall be verified. This process shall be repeated until the preceding and subsequent inspections meet the accuracy requirements.

Coding accuracy checks shall be submitted to the Contract Administrator along with the corresponding video recording.

409.07.04 CCTV Inspection

409.07.04.01 General

CCTV Camera inspections shall be done by the Contractor in accordance with the pipe condition coding practices as outlined in the MSCC or Pipeline Assessment and Certification Program (PACP®) Canadian Edition including CSA PLUS 4012 TECHNICAL GUIDE Visual inspection of sewer pipe or as specified in the Contract Documents

The work shall include a CCTV inspection of new and existing pipelines, which include storm and sanitary sewers, watermains, pipe culverts or other accessible conduits and the preparation of all video, digital, and written reports.

A certified CCTV operator shall be employed to operate the inspection equipment and code the inspection.

A fixed camera may be used for sewer pipe or culverts less than 300 mm in diameter. For sewer pipe or culverts equal to or greater than 300 mm, a pan and tilt camera shall be used. Each camera shall have an accepted sample submissions report prior to being used for inspection work. The camera lens shall be kept clean at all times during the inspection.

Flow control measures as specified in the Contract Documents shall be implemented to ensure a minimum of 80% of the height of the pipeline is visible for the entire inspection and shall be approved by the Contract Administrator.

All fog shall be evacuated from the pipeline and the pipeline kept clear of fog during the inspection.

At the start of each pipeline being inspectioned, the length of pipeline from zero chainage up to the cable calibration point shall be recorded and reported in order to obtain a full record of one of the following:

a) Sewer Pipe length from the inside face of the maintenance hole to the inside face of the next maintenance hole or outlet end of the sewer pipe

b) Culvert Pipe length from one end of the pipe culvert to the other

c) Watermain Pipe length from the valve pit entry point to the valve pit exit point or termination of the cement mortar lining.

The position meter-reading entered on to the data display at the cable calibration point shall allow for the distance from the start of the inspection to the cable calibration point so that the meter-reading at the start of the inspection is zero.

In the case of inspectioning through a maintenance hole when a new header sheet is required, the meter-reading shall be set at zero with the camera focused on the outgoing pipe entrance.

At the start of each pipe segment to be inspected, a data generator shall electronically generate and clearly display on the viewing monitor and video recording a record of data in alphanumeric form containing the following minimum header information:

a) Automatic update of the camera’s meter-reading position in the pipeline from adjusted zero.
b) Pipeline dimensions.
c) Maintenance hole and pipe length reference numbers.
d) Date of inspection.
e) Road, Park or Highway name and location.
f) Direction of inspection.
g) Time of start of inspection.
h) Pipeline use.

Once the inspection of the pipe segment is underway, an automatic update of the camera's meter-reading position in the pipeline from zero in metres and tenths of a metre shall be continually displayed.

The camera shall be stopped when defects are being noted and coded.

Defects in each pipeline length shall be recorded according to the MSCC, (PACP®) Canadian Edition including CSA PLUS 4012 TECHNICAL GUIDE or as specified in the Contract Documents. Any variation from the manuals shall be noted in the inspection report.
The inspection shall be restarted at the opposite end of the pipeline if a blockage or obstruction is encountered.

Inspections shall be recorded in colour.

Digital video recordings may be saved to a hard drive and transferred to a portable hard disk drive, compact disc, or digital video for submission.

A digital format video recording of an inspection shall be produced in colour from a first generation recording by one of the following methods:

a) A computer system and a video capture card shall be used to capture the recording continuously, regardless of the progression of the inspection. Prior to submission, the raw digital data shall be edited to remove pauses when the inspection progress was not continuous.

b) A computer system and a video capture card shall be used to intermittently capture the recording. Prior to submission, the raw digital file shall be edited to form one continuous file.

c) Specialized video recording equipment capable of pausing and resuming live recording shall be used to capture original recording. A single file is to be produced for submission.

Video capture equipment shall be capable of capturing digital video from first generation recordings with no frame loss.

Non-linear video editing software shall be used to edit digital videos. Edited digital files shall not be recompressed.

409.07.04.02 Camera Position

The camera lens shall be positioned centrally in a circular pipeline and at two-thirds of the vertical dimension in a non-circular pipeline with a positioning tolerance of ±10% of the vertical pipeline dimension.

In all instances, the camera lens shall be positioned looking along the longitudinal axis of the pipeline.

409.07.04.03 Camera Travel Speed

The travelling speed of the camera in the pipeline shall be limited to:

a) 0.10 m/s for pipeline of diameter less than 200 mm.

b) 0.15 m/s for diameters exceeding 200 mm but not exceeding 310 mm.

c) 0.20 m/s for diameters exceeding 310 mm.

409.07.04.04 Camera Position Meter-Reading Device

A suitable meter-reading device shall be used that enables the cable length to be accurately measured to indicate the location of the camera. The meter-reading device shall be accurate to ±1% of the length of the sewer being inspectioned. The tolerance shall be demonstrated using one or both of the following methods in conjunction with a linear measurement audit form that shall be completed each day during the inspection:

a) Cable calibration device.

b) Tape measurement of the surface distance between maintenance holes.

If the accuracy of the measuring device fails, it is to be replaced. The Contract Administrator may require that the lengths of pipeline first inspected with the original measuring device be reinspectioned using the new measuring device.

409.07.05 Final Documentation

409.07.05.01 Inspection Reporting

Inspection reports shall be submitted to the Contract Administrator in the following formats, with the noted number of copies, within 10 Business Days of the completion of the fieldwork:

a) 3 printed hard copies of the inspection report, unless otherwise specified in the Contract Documents.

b) 2 portable digital drives, each containing the identical inspection report information as in the printed copies, unless otherwise specified in the Contract Documents.

c) 2 copies of the digital video recording, unless otherwise specified in the Contract Documents.

Entire inspections shall be contained within one digital file on a digital storage device, as applicable. When possible, reverse set-up inspections shall be recorded immediately after the original inspection.

Each digital report and video recording file shall contain the file name, as specified by the Owner and may include the following:

a) Tender, Project, or Contract number
b) E<Entity number>
c) F<From entity number>
d) T<To entity number>
e) Street, Park, or Highway Name
f) M<Measured length>
g) I<Inspected length>
h) <Inspection direction: DS or US> (DownStream or UpStream)
i) <Letter designating inspection sequence> (“A” indicates partial inspection that would include a “B” or more to this entity for a complete manhole to manhole inspection)

For example: “910-200_ESP729_F5328_T5350_BERRY_ST_M150_I39_US_B.MPEG” indicates that this is from contract 910-200, the pipe segment is referred to as SP729, inspection is from MH 5328 to MH 5350 on Berry Street, records say 150m long, actual inspection was 39m in the upstream deployment, and this is the second or “B” partial inspection of this entity, of this video recording.

All required header information fields shall be completed and verified for correctness. The software used to produce the inspection report shall not allow the operator to continue inputting information until the preceding field has been completed. The report shall be printed and presented as specified in the Contract Documents.

All dimensions in the inspection report shall be metric.

The inspection report shall identify major defects and shall include photographs when the need for photographs is specified in the Contract Documents.

409.07.05.02 Drawings

One clean set of the Owner's drawings showing maintenance hole numbers that coincide with the coding sheets and videotapes shall be returned to the Contract Administrator on completion of the inspection. The drawings shall be clearly annotated to show any discrepancies between the drawings and the inspection report. Such discrepancies shall be brought to the attention of the Contract Administrator during the inspection.

409.07.06 Management of Excess Material

Management of excess material shall be as specified in the Contract Documents.

409.08 QUALITY ASSURANCE

Upon submission, printed and digital inspection reports, and digital MPEG video recordings, magnetic data files, and coding accuracy checks shall be reviewed to ensure compliance with the Contract Documents.

Submittals shall be reviewed by the Contract Administrator and their acceptance confirmed within 10 Business Days of submission. Only inspections with minimum accuracy for header information of 95% and minimum detail accuracy for defects and features of 85% will be accepted. Non-compliant submissions will be returned for correction. Corrected submissions shall be returned to the Contract Administrator for review within 5 Business Days.

Operators failing to meet the coding accuracy requirements on two occasions shall not be permitted to code on the remainder of the Contract, unless they successfully re-attain NASSCO qualification based on the standard being used (i.e., Canadian Edition of PACP or WRc).

409.09 MEASUREMENT FOR PAYMENT

409.09.01 Actual Measurement

Measurement for a CCTV inspection of pipeline shall be measured in metres on the ground surface along the centreline of the pipe sewer from the centre of one drainage structure to the centre of another drainage structure or outlet end of the pipe sewer. Measurement for pipe culverts shall be from one end of the pipe culvert to the other end of the pipe.

Measurement for a CCTV inspection of watermain shall be measured in metres on the ground surface along the centreline of the watermain from the valve pit entry point to the valve pit exit point or termination of the cement mortar lining.

In the event that a CCTV inspection is terminated due to a blockage or collapsed pipe or the pipe is inaccessible, measurement shall be in metres for the actual length of pipeline inspected as determined from the chainage indication on the record media.

409.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clause under Actual Measurement.

409.10 BASIS OF PAYMENT

409.10.01 CCTV Inspection - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

When the Contract does not contain a separate tender item for CCTV inspection, the Contract price for the appropriate tender item for the installation of pipe sewers, pipe culverts, or the lining of watermains shall include full compensation for all labour, Equipment, and Material to do the work of CCTV inspection.

Non-compliant submissions returned for correction shall be corrected and resubmitted at no expense to the Owner.

Appendix 409-A, November 2017
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- The type of media storage. (409.05.01)

- Additional or different labelling information for media storage (409.05.01)

- Resolutions of digital photographs. (409.05.01.01)

- Flow control measures. (409.07.04.01)

Flow control measures may include such items as scheduling work for off-peak flow times, plug or block flow at upstream manhole, and temporary by-pass pump flow around inspection section. (409.07.04.01)

- Which standard of coding classification will be followed throughout the CCTV inspection and reference the standard being used, when applicable. (409.07.04.01)

- Required video header information (409.07.04.01)

- Inspection report and video file naming details (409.07.05.01)

The designer should determine if the following is required and if so, specify it in the Contract Documents:

- If the Contractor is to clean and flush pipelines prior to commencement of CCTV inspection. (409.07.01)

- If photographs are required as part of the CCTV inspection. (409.07.05)

- If payment for CCTV inspection is to be included in the Contract price for installing storm or sanitary pipe sewers, or pipe culverts, or if payment will be a separate CCTV item or items. (409.10.01)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

CONSTRUCTION SPECIFICATION FOR PIPE SEWER INSTALLATION IN OPEN CUT

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410-A **Commentary**

410.01 SCOPE

This specification covers the requirements for the installation of storm and sanitary pipe sewers, laterals, service connections, and concrete appurtenances in open cut.

410.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

410.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

410.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 206	Grading
OPSS 401	Trenching, Backfilling, and Compacting
OPSS 404	Support Systems
OPSS 407	Maintenance Hole, Catch Basin, Ditch Inlet, and Valve Chamber Installation
OPSS 409	Closed-Circuit Television Inspection of Pipelines
OPSS 490	Site Preparation for Pipelines, Utilities, and Associated Structures
OPSS 491	Preservation, Protection, and Reconstruction of Existing Facilities
OPSS 492	Site Restoration Following Installation of Pipelines, Utilities, and Associated Structures
OPSS 510	Removal
OPSS 517	Dewatering of Pipeline, Utility, and Associated Structure Excavation
OPSS 539	Temporary Protection Systems
OPSS 904	Concrete Structures
OPSS 905	Steel Reinforcement for Concrete

Ontario Provincial Standard Specifications, Material

OPSS 1004	Aggregates - Miscellaneous
OPSS 1205	Clay Seal
OPSS 1301	Cementing Materials
OPSS 1302	Water
OPSS 1350	Concrete - Materials and Production
OPSS 1440	Steel Reinforcement for Concrete
OPSS 1801	Corrugated Steel Pipe Products
OPSS 1820	Circular Concrete Pipe
OPSS 1840	Non-Pressure Polyethylene Plastic Pipe Products
OPSS 1841	Non-Pressure Polyvinyl Chloride (PVC) Pipe Products

OPSS 1843 Non-Pressure Polypropylene (PP) Plastic Pipe Products
OPSS 1860 Geotextiles

CSA Standards

B182.1-11 Plastic Drain and Sewer Pipe and Pipe Fittings
[Part of B1800-11, Plastic Non-Pressure Pipe Compendium]

ASTM International

C 507-12 Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe

410.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Backfilling means the operation of filling the trench with bedding, cover, and backfill material or embedment and backfill material.

Concrete Appurtenances means concrete head walls, cut-off walls, stiffeners, aprons, collars, and any other concrete fixtures associated with the pipe sewer, excluding concrete bedding or concrete structures specified in the Contract Documents.

Dimension Ratio means the average specified outside diameter of a pipe divided by the minimum specified wall thickness.

Drainage Structure means a maintenance hole, catch basin, or ditch inlet.

Excavation, Earth and Rock means the excavation classified as earth and rock according to OPSS 206.

Flexible Pipe means pipe that can deflect 2% or more without cracking, such as polyvinyl chloride or polyethylene or steel pipe.

Pipe Class means a pipe's physical material specification, such as load and pressure ratings, wall thickness, protective coatings, corrugation profiles, ring stiffness constants, and reinforcement.

Pipe Run means a section of a pipe sewer between two drainage structures or between a drainage structure and an outlet.

Pipe Sewer means an installation designed for the conveyance of sanitary sewage or storm water using preformed or precast pipe sections, circular or non-circular in cross-section, laid end to end using suitable jointing material and connected by maintenance holes for sanitary pipe sewers and by maintenance holes, catch basins, ditch inlets, or concrete appurtenances for storm pipe sewers.

Pipe Type means a pipe's inner wall design, which can be smooth or corrugated.

Polypropylene Plastic means a material made with virgin polymers in which propylene is essentially the sole monomer.

Service Connection means the pipe used to convey sanitary sewage or storm water from the property line to the main sanitary or storm pipe sewer respectively.

410.05 MATERIALS

410.05.01 Pipe Materials

410.05.01.01 General

Pipe sewer size, type, and class shall be as specified in the Contract Documents.

Pipe sewer size and class shall be consistent throughout a pipe run as specified in the Contract Documents. Pipe type shall be consistent throughout a pipe sewer as specified in the Contract Documents.

Fittings shall be suitable for and compatible with the pipe type and class for which they will be used.

410.05.01.02 Concrete Pipe

Circular concrete pipe and joints shall be according to OPSS 1820.

Elliptical concrete pipe and joints shall be according to ASTM C 507.

410.05.01.03 Corrugated Steel Pipe Products

Corrugated steel pipe products shall be according to OPSS 1801.

410.05.01.04 Polyethylene Pipe Products

Polyethylene pipe products shall be according to OPSS 1840.

410.05.01.05 Polyvinyl Chloride Pipe Products

Polyvinyl chloride pipe products shall be according to OPSS 1841.

Polyvinyl chloride service connection pipe shall be according to CSA B182.1 and shall have bell and spigot joints with elastomeric gaskets.

410.05.01.06 Polypropylene Plastic Pipe Products

Polypropylene plastic pipe products shall be according to OPSS 1843.

410.05.02 Mortar

Mortar for joints shall be composed of one part general use Portland cement and two parts mortar sand, wetted with only sufficient water to make the mixture plastic. The mortar sand shall be according to OPSS 1004, the general use Portland cement shall be according to OPSS 1301, and the water shall be according to OPSS 1302.

410.05.03 Clay Seal

Clay seal material shall be according to OPSS 1205.

410.05.04 Concrete

Concrete for concrete appurtenances shall be according to OPSS 1350 with a nominal minimum 28-Day compressive strength of 30 MPa.

410.05.05 Steel Reinforcement

Steel reinforcement shall be of the size and grade specified in the Contract Documents and shall be according to OPSS 1440.

410.05.06 Geotextile

Geotextile shall be according to OPSS 1860.

410.07 CONSTRUCTION

410.07.01 Site Preparation

Site preparation shall be according to OPSS 490.

410.07.02 Removals

Removals shall be according to OPSS 510.

410.07.03 Preservation and Protection of Existing Facilities

Preservation and protection of existing facilities shall be according to OPSS 491.

410.07.04 Protection Against Floatation

Damage to the pipeline due to floatation shall be prevented during construction and until completion of the work.

410.07.05 Cold Weather Work

All work shall be protected from freezing. Pipes and bedding material shall not be placed on frozen ground.

410.07.06 Transporting, Unloading, Storing, and Handling Pipe

Manufacturer's recommendations for transporting, unloading, storing, and handling of pipe shall be followed.

All pipes, fittings, and gaskets that are unsound or damaged shall be rejected.

410.07.07 Excavation

Excavation for the placement of pipe sewers shall be according to OPSS 401.

410.07.08 Support Systems

Support systems shall be according to OPSS 404.

410.07.09 Dewatering

Dewatering shall be according to OPSS 517.

410.07.10 Protection Systems

The construction of all protection systems shall be according to OPSS 539. When the stability, safety, or function of an existing roadway, railway, other works, or proposed works may be impaired due to the method of operation, such protection as may be required shall be provided. Protection may include sheathing, shoring, and the driving of piles, when necessary, to prevent damage to such works or proposed works.

410.07.11 Backfilling and Compacting

Backfilling and compacting shall be according to OPSS 401.

410.07.12 Pipe Installation

410.07.12.01 General

If a universal dimple coupler or any other coupler does not follow the contour of the flexible pipe sections to be joined, polyethylene gaskets shall then be installed at all joints when such couplers are used. Polyethylene gaskets shall be installed symmetrically about the pipe joint, between the coupler and the pipe, and shall be of sufficient length to equal the circumference of the pipe plus a minimum overlap of 300 mm.

Pipe shall be laid within the alignment and grade tolerances specified in the Contract Documents. When bell and spigot pipe is laid, the bell end of the pipe shall be laid upgrade.

Pipe shall be kept clean and dry as work progresses. The trench shall be kept dry. A removable watertight bulkhead shall be installed at the open end of the last pipe laid whenever work is suspended.

Pipe shall not be laid until the preceding pipe joint has been completed and the pipe is carefully embedded and secured in place.

When the Owner raises or lowers the invert of a pipe sewer by 150 mm or less, it shall not constitute a Change in the Work and no adjustment shall be made to the payment. When the invert of a pipe sewer is raised or lowered by more than 150 mm, it shall constitute a Change in the Work for the full extent of the change from the original grade.

When installing gaskets, all pipe ends shall be thoroughly cleaned. For gaskets requiring field lubrication, a lubricant recommended by the pipe manufacturer shall be used.

When gaskets have been affixed, the pipe shall be handled in a way so that the gasket is not damaged, displaced, or contaminated with foreign matter. Any gasket displaced or contaminated shall be removed, cleaned, and lubricated, if required, and reinstalled before closure of the joint is attempted. When specified in the Contract Documents, nitrile gaskets shall be used.

The pipe shall be properly positioned by means of an appropriate mechanism. Sufficient pressure shall be applied in making the joint to ensure that the joint is in position. Sufficient restraint shall be applied to the line to ensure that joints are held in this position.

Once the pipe has been jointed, a test shall be made with a feeler gauge at intervals around the joint to ensure that the gasket has not been displaced from the spigot groove. If the gasket is found out of position, the joint shall be opened and the gasket placed in its proper position. If necessary, a new gasket shall be installed.

410.07.12.02 Circular Concrete Pipe

All circular concrete pipe joints shall have elastomeric gaskets.

410.07.12.03 Non-Circular Concrete Pipe

Elliptical concrete pipes and joints shall be used for storm pipe sewers only.

All non-circular concrete pipe joints shall be according to the procedures recommended by the manufacturer.

410.07.12.04 Corrugated Steel Pipe Products

Corrugated steel pipe products shall be used for storm pipe sewers only.

Helical corrugated steel pipe without rerolled ends shall be installed so that the helix angle is constant for the total length of the installation. Each pipe section shall be installed next to the previous section so that the lockseam forms a continuous helix. For rerolled ends, the correct fit of the coupling system does not depend on the location of the helical lockseam and corrugation.

Corrugated steel pipe sections shall be joined by means of steel couplers. The couplers shall be installed to lap approximately equal portions of the pipes being connected so that the corrugations or projections of the coupler properly engage the pipe corrugations. As the coupler is being tightened, it shall be tapped with a mallet to take up the slack.

When joint seals are specified in the Contract Documents, they shall be installed immediately prior to the installation of steel couplers.

410.07.12.05 Polyethylene Pipe

Polyethylene pipe shall be jointed by one of the following methods, as recommended by the manufacturer:

a) Bell and Spigot

b) Welded Joint

c) Thermal Fusion Joint

d) Screw-on Coupler

e) Split Coupler

f) Threaded Joint

410.07.12.06 Polyvinyl Chloride Pipe

Polyvinyl chloride pipe shall be jointed, as recommended by the manufacturer, using a bell and spigot joint with an elastomeric gasket.

At the end of a day's work, the last pipe shall be blocked as may be required to prevent movement.

410.07.12.07 Polypropylene Pipe

Polypropylene pipe shall be jointed by means of a bell and spigot joint with elastomeric gasket or a coupler joint as recommended by the manufacturer to satisfy the pipe joint specification.

410.07.13 Service Connections

Service connections to the main pipe sewer shall be made using factory made tees or wyes, strap-on-saddles, or other approved saddles. Factory made tees or wyes shall be used for all service connections when the diameter of the main pipe sewer is:

a) less than 450 mm; or

b) less than twice the diameter of the service connection.

Strap-on-saddles shall be installed before laying the pipe.

Holes in the main pipe sewer shall be cut with approved cutters and shall be the minimum diameter required to accept the service connection saddle. If mortar-on saddles are used, the inside of the pipe shall be mortared at the connection.

Service connections shall be plugged at the property line with watertight caps or plugs. Plugs or caps shall be braced sufficiently to withstand test pressures.

When existing service connections shall be connected to new pipe sewers or service connections, proper jointing procedures shall be used.

410.07.14 Marking and Recording Service Connections

A painted temporary location marker consisting of a 50 x 75 mm stake or two short sections of lumber connected by a piece of heavy gauge wire shall be placed at the end of the plugged or capped service connection. The marker shall be placed from 300 mm below the finished grade to a point 300 mm above the plugged end of the service pipe.

A painted surface stake, 50 x 75 x 450 mm long, shall be placed after trench restoration.

Service connections shall not be backfilled until they have been inspected and measurements of location have been taken by the Contract Administrator.

410.07.15 Breaking into Maintenance Holes, Catch Basins, Ditch Inlets, Pipe Culverts, and Pipe Sewers

Openings shall be made as necessary in an existing maintenance hole, catch basin, ditch inlet, pipe culvert, or pipe sewer to install the new pipe sewer and connect it to the structure according to OPSS 407. Benching in existing maintenance holes shall be altered to accommodate the flow in the new pipe sewer system.

When specified in the Contract Documents, the opening for the connection of a subdrain outlet shall be formed by coring. The subdrain outlet pipe shall be sealed into place using non-shrink grout. When specified in the Contract Documents, a 50 mm diameter weep hole shall be cored into the same wall as the subdrain connection and at the same invert elevation.

410.07.16 Field Testing

410.07.16.01 General

Field tests described in this subsection shall be conducted when specified in the Contract Documents and applied to sanitary and storm pipe sewers. All tests shall be carried out in the presence of and accepted by the Contract Administrator.

When specified in the Contract Documents, leakage tests shall be carried out on completed pipe sewers 1,200 mm in diameter and smaller. There shall be no visible leakage for pipe sewers larger than 1,200 mm diameter.

Testing shall be carried out from maintenance hole to maintenance hole, including house service connections as work progresses.

The construction of new mainline pipe sewers shall not proceed when three previously placed sections of the pipe sewer have not been tested or have been tested and are unsatisfactory.

Leakage up to 25% in excess of the calculated limits shall be approved in any test section provided that the excess is offset by lower leakage measurements in adjacent sections so that the total leakage is within the allowable limits for the combined sections.

Pipe sewers shall be repaired and retested, as required, until the test results are within the limits specified in this specification. Visible leaks shall be repaired regardless of the test results.

No part of the work shall be accepted until the pipe sewers are satisfactorily tested following completion of installation of service connections and backfilling.

410.07.16.02 Prequalification Leakage Tests

Prequalification leakage tests shall be carried out as either infiltration or exfiltration tests, as required.

The test shall be performed on the first section of the pipe sewer of each size, not less than 100 m in length, installed by each crew in order to prequalify the crew and the material. Tests may be carried out prior to service connections being installed in the section being tested.

When tests are unsatisfactory, the test section shall be repaired and retested until satisfactory results are obtained.

410.07.16.03 Infiltration Test

Dewatering operations shall be discontinued at least three days prior to conducting the test and allow for the groundwater level to stabilize. Infiltration tests shall be conducted when the groundwater level at the time of testing is 600 mm or more above the crown of the pipe for the entire length of the test section. The test section is normally between adjacent maintenance holes.

A watertight bulkhead shall be constructed at the upstream end of the test section. All service laterals, stubs, and fittings shall be plugged or capped to prevent water entering at these locations. A V-notch weir or other suitable measuring device shall be installed at the downstream end of the test section. Infiltrating water shall be allowed to build up behind the weir until the flow through the V-notch has stabilized. The rate of flow shall then be measured. The rate of flow shall not exceed the maximum allowable infiltration calculated for the test section. Allowable infiltration shall be calculated as 0.075 litres/millimetre diameter/100 metres of pipe sewer/hour.

410.07.16.04 Exfiltration Test

410.07.16.04.01 General

Exfiltration tests shall be conducted when the groundwater level is lower than 600 mm above the crown of the pipe or the highest point of the highest service connection included in the test section.

The test section is normally between adjacent maintenance holes. The test section of the pipe sewer shall be isolated by temporarily plugging the downstream end and all incoming pipes of the upstream maintenance hole. All service laterals, stubs, and fittings are plugged or capped to prevent water entering at these locations.

410.07.16.04.02 Testing With Water

The test section shall be slowly filled with water ensuring that all air is removed from the line. A period of 24 hours for absorption or expansion shall be allowed prior to starting the test, except if exfiltration requirements are met by a test carried out during the absorption period.

Water shall be added to the pipeline prior to testing until there is a head in the upstream maintenance hole of 600 mm minimum over the crown of the pipe or at least 600 mm above the existing groundwater level, whichever is greater. The maximum limit of the net internal head on the line is 8 m. In calculating the net internal head, allowance for groundwater head, if any, shall be made.

The distance from the maintenance hole frame to the surface of the water shall be measured. After allowing the water to stand for one hour, the distance from the frame to the surface of the water shall again be measured. The leakage shall be calculated using volumes.

The leakage at the end of the test period shall not exceed the maximum allowable calculated for the test section. Allowable leakage shall be calculated as 0.075 litres/millimetre diameter/100 metres of pipe sewer/hour.

An allowance of 3.0 litres per hour per metre of head above the invert for each maintenance hole included in the test section shall be made.

Maintenance holes shall be tested separately, if the test section fails.

410.07.16.04.03 Low Pressure Air Testing

The Contract Administrator may allow or require testing by use of air when water is not readily available or the differential head in the test section is greater than 8 m or freezing temperatures exist.

Air control equipment that includes a shut off valve, safety valve, pressure regulating valve, pressure reduction valve and monitoring pressure gauge with pressure range from 0 to 35 kPa with minimum divisions of 0.5 kPa and accuracy of approximately 0.25 kPa shall be provided.

Tests shall be conducted between two consecutive maintenance holes. The test section shall be plugged at each end. One plug shall be equipped with an air inlet connection to fill the pipe sewer system with air.

The test section shall be filled slowly until a constant pressure of 24 kPa is maintained. If the groundwater is above the pipe sewer being tested, the air pressure shall be increased by 3.0 kPa for each 300 mm that the groundwater level is above the invert of the pipe.

The air pressure shall be stabilized for five minutes and then regulated to maintain it to 20.5 kPa plus the allowance for groundwater, if any. After the stabilization period, the time taken for a pressure loss of 3.5 kPa shall be recorded.

The time taken for a pressure drop of 3.5 kPa shall not be less than the times shown in Table 1.

If the length of the test section is greater than the length for minimum time, the new testing time shall be a product of the length of test section multiplied by the time shown in Table 1 for the appropriate size pipe.

If the results of an air test are marginal, the Contract Administrator may require the section to be retested using water.

410.07.16.05 Deflection Testing of Pipe Sewers

Ring deflection testing shall be performed on all pipe sewers constructed using flexible pipe. The allowable deflected pipe diameter is calculated as:

Pipes 100 to 750 mm:	7.5% of the Base Inside Diameter of the Pipe
Pipes Greater Than 750 mm:	5.0% of the Base Inside Diameter of the Pipe

Where:

Base Inside Diameter is defined in the CSA or ASTM standard to which the pipe is manufactured.

A suitably designed device as defined below shall be pulled through the pipe sewer to demonstrate that the pipe deflection does not exceed the allowable deflected pipe diameter. The device shall be pulled manually through the pipe not sooner than 30 Days after the completion of backfilling and installation of service connections.

The suitably designed device shall be a mandrel, cylindrical in shape, and constructed with an odd number of evenly spaced arms or prongs, minimum 9 in number. The minimum diameter of the circle scribed around the outside of the mandrel arms shall be equal to the allowable deflected pipe diameter $\pm$ 1 mm. The contact length of the mandrel shall be measured between the points of contact on the mandrel arm or between sets of prongs. This length shall not be less than that shown in Table 2.

The mandrel shall be checked with a go-no-go proving ring. The proving ring shall have a diameter equal to the allowable deflected pipe diameter $\pm$ 0.1 mm. An acceptable mandrel shall not pass through the proving ring. The proving ring shall be fabricated from steel a minimum of 6 mm thick.

Any section of pipe that does not allow the mandrel to pass shall be considered to have failed the deflection test.

All sections of pipe that fail the deflection test shall be repaired and retested.

410.07.16.06 Closed-Circuit Television (CCTV) Inspection

Pipe sewers shall be inspected using CCTV equipment. CCTV inspection of pipe sewers shall be according to OPSS 409.

410.07.17 Cleaning and Flushing of Pipe Sewers

When specified in the Contract Documents, all pipe sewers shall be cleaned and flushed immediately prior to inspection and acceptance.

410.07.18 Clay Seals

Clay seals shall be placed as specified in the Contract Documents and compacted to 95% of the maximum dry density.

410.07.19 Concrete Appurtenances

Concrete appurtenances shall be constructed as specified in the Contract Documents. Concrete in concrete appurtenances shall be placed according to OPSS 904. Steel reinforcement shall be placed according to OPSS 905. Steel grating shall be installed when specified in the Contract Documents.

410.07.20 Site Restoration

Site restoration shall be according to OPSS 492.

410.07.21 Management of Excess Material

Management of excess material shall be as specified in the Contract Documents.

410.09 MEASUREMENT FOR PAYMENT

410.09.01 Actual Measurement

410.09.01.01 Pipe Sewers

Measurement of pipe sewers shall be by length in metres along the horizontal centreline length of the pipe from the centre of one drainage structure to the centre of another drainage structure or outlet end of the pipe sewer. When the grade of the pipe sewer is 10% or greater, the above measurement is then of the slope length.

410.09.01.02 Service Connections

Measurement of the service connections shall be by length in metres along its horizontal centreline from the centreline of the main pipe sewer to the end of the service connection.

410.09.01.03 Breaking into Maintenance Holes, Catch Basins, Ditch Inlets, Pipe Culverts, and Pipe Sewers

For measurement purposes, a count shall be made of the number of openings made in maintenance holes, catch basins, ditch inlets, pipe culverts and pipe sewers.

410.09.01.04 Concrete Appurtenances

Measurement for concrete appurtenances shall be by volume in cubic metres for the volume of concrete placed. Alternatively, concrete appurtenances may be a lump sum item.

410.09.01.05 Clay Seal

Measurement for clay seal shall be by volume in cubic metres for the volume of clay placed. Alternatively, clay seal may be a lump sum item.

410.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

410.10 BASIS OF PAYMENT

410.10.01 ***"size, type, class"*** **Pipe Sewers - Item**
Service Connections - Item
Breaking into Maintenance Holes, Catch Basins, Ditch Inlets, Culverts and Sewers - Item
Concrete Appurtenances - Item
Clay Seal - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

410.10.02 Closed-Circuit Television (CCTV) Inspection

When a CCTV inspection of pipe sewers is specified in the Contract Documents, payment for CCTV inspection shall be according to OPSS 409.

TABLE 1
Exfiltration Test - Low Pressure Air Testing

NominalPipe Size mm	MinimumTime min:sec	Length for Minimum Time m	Time For Longer Length sec
100	1:53	182	0.623
150	2:50	121	1.140
200	3:47	91	2.493
250	4:43	73	3.893
300	5:40	61	5.606
375	7:05	48	8.761
450	8:30	41	12.615
525	9:55	35	17.171
600	11:20	30	22.425
675	12:45	27	28.382
750	14:10	24	35.040
825	15:35	22	42.397
900	17:00	20	50.450

TABLE 2
Deflection Testing of Pipe Sewers

Nominal Pipe Size mm	Mandrel Contact Length mm
150	100
200	150
250	200
300	250
350	300
375	300
400	300
450	350
500	400
525	450
600	500
675	575
750	675
900	750
1050	900
1200	1050

Appendix 410-A, November 2018
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Pipe sewer size, type, and class. (410.05.01.01)

- Pipe size. (410.05.01.01)

- Size and grade of steel reinforcement. (410.05.05)

- Alignment and grade tolerances for the pipe installation. (410.07.12.01)

- Placement of clay seals. (410.07.18)

- Requirements to construct concrete appurtenances. (410.07.19)

- Depth of backfill over the pipe sewer. (410.07.20)

The designer should determine if the following are required and, if so, add the requirement in the Contract Documents:

- Use of nitrile gaskets. (410.07.12.01)

- Use of joint seals with corrugated steel pipe products. (410.07.12.04)

- Coring for the installation of subdrain. (410.07.15)

- Coring of a 50 mm diameter weep hole. (410.07.15)

- Field tests. (410.07.16.01)

- Cleaning and flushing prior to inspection and acceptance. (410.07.17)

- Use of steel grating. (410.07.19)

- Payment of concrete appurtenances by volume or lump sum. (410.09.01.04)

The tender item description for pipe sewer should include reference to one or more of the attributes shown, i.e., *size, type, class*. (410.10.01)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Appendix 410-A

Related Ontario Provincial Standard Drawings

OPSD 708.010	Catch Basin Connection for Rigid Main Pipe Sewer
OPSD 708.020	Support for Pipe at Catch Basin or Maintenance Hole
OPSD 708.030	Catch Basin Connection for Flexible Main Pipe Sewer
OPSD 802.010	Flexible Pipe Embedment and Backfill Earth Excavation
OPSD 802.013	Flexible Pipe Embedment and Backfill Rock Excavation
OPSD 802.014	Flexible Pipe Embedment in Embankment Original Ground: Earth or Rock
OPSD 802.020	Flexible Pipe Arch Embedment and Backfill Earth Excavation
OPSD 802.023	Flexible Pipe Arch Embedment and Backfill Rock Excavation
OPSD 802.024	Flexible Pipe Arch Embedment in Embankment Original Ground: Earth or Rock
OPSD 802.030	Rigid Pipe Bedding, Cover, and Backfill, Type 1 or 2 Soil - Earth Excavation
OPSD 802.031	Rigid Pipe Bedding, Cover, and Backfill, Type 3 Soil - Earth Excavation
OPSD 802.032	Rigid Pipe Bedding, Cover, and Backfill, Type 4 Soil - Earth Excavation
OPSD 802.033	Rigid Pipe Bedding, Cover, and Backfill, Rock Excavation
OPSD 802.034	Rigid Pipe Bedding and Cover in Embankment, Original Ground: Earth or Rock
OPSD 802.050	Horizontal Elliptical Rigid Pipe Bedding, Cover, and Backfill, Type 1 or 2 Soil - Earth Excavation
OPSD 802.051	Horizontal Elliptical Rigid Pipe Bedding, Cover, and Backfill, Type 3 Soil - Earth Excavation
OPSD 802.052	Horizontal Elliptical Rigid Pipe Bedding, Cover, and Backfill, Type 4 Soil - Earth Excavation
OPSD 802.053	Horizontal Elliptical Rigid Pipe Bedding, Cover, and Backfill, Rock Excavation
OPSD 802.054	Horizontal Elliptical Rigid Pipe Bedding and Cover in Embankment, Original Ground: Earth or Rock
OPSD 802.095	Clay Seal for Pipe Trenches
OPSD 804.030	Concrete Headwall for Pipe Less Than 900 mm Diameter
OPSD 804.040	Concrete Headwall for Sewer or Culvert Pipe
OPSD 804.050	Grating for Concrete Endwall
OPSD 805.010	Height of Fill Table, Round Corrugated Steel Pipe and Structural Plate Corrugated Steel Pipe
OPSD 805.020	Height of Fill Table, Corrugated Steel Pipe Arch and Structural Plate Corrugated Steel Pipe Arch
OPSD 805.030	Height of Fill Table, Spiral Rib Round Pipe
OPSD 805.040	Height of Fill Table, Spiral Rib Pipe Arch
OPSD 806.020	Height of Fill Table, Dual Wall Corrugated Polyethylene Gravity Sewer Pipe, 210 and 320 kPa
OPSD 806.021	Height of Fill Table, Closed Profile Wall Polyethylene Pipe, RSC 160 and 250
OPSD 806.022	Height of Fill Table, Dual Wall Corrugated Polyethylene Gravity Sewer Pipe, RSC 100 and RSC 160
OPSD 806.030	Height of Fill Table, Dual and Triple Wall Corrugated Polypropylene Gravity Sewer Pipe, 320 kPa
OPSD 806.040	Height of Fill Table, Polyvinyl Chloride Gravity Sewer Pipe, 210, 320, and 625 kPa
OPSD 806.060	Height of Fill Table, Polyvinyl Chloride Pressure Pipe for Different Dimension Ratios
OPSD 807.010	Height of Fill Table, Reinforced Concrete Pipe - Confined Trench Class 50-D, 65-D, 100-D, and 140-D
OPSD 807.030	Height of Fill Table, Reinforced Concrete Pipe - Embankment Class 50-D, 65-D, 100-D, and 140-D
OPSD 807.040	Height of Fill Table - Nonreinforced Concrete Pipe Class 3
OPSD 807.050	Height of Fill Table, Horizontal Elliptical Concrete Pipe Class HE-A, HE-I, HE-II, HE-III, and HE-IV
OPSD 1006.010	Sewer Service Connections for Rigid Main Pipe Sewer
OPSD 1006.020	Sewer Service Connections for Flexible Main Pipe Sewer

CONSTRUCTION SPECIFICATION FOR THE CLEANING AND FLUSHING OF CULVERTS, WALL DRAINS, PIPE SEWERS, CATCH BASINS, MAINTENANCE HOLES, DITCH INLETS, AND OIL/GRIT SEPARATORS

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411.01 SCOPE

This specification covers the requirements for the cleaning and flushing of culverts, wall drains, pipe sewers, catch basins, maintenance holes, ditch inlets, and oil/grit separators by means of pressure washing for the removal of corrosion deposits buildup and management of cleanout material.

411.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be as specified in the Contract Documents.

411.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

411.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 409	Closed-Circuit Television Inspection of Sewers
OPSS 410	Pipe Sewer Installation in Open Cut
OPSS 421	Pipe Culvert Installation in Open Cut
OPSS 517	Dewatering of Excavation

Ontario Ministry of Transportation Publications

MTO Environmental Guide for Fisheries – Best Management Practices Manual 2020

411.03 DEFINITIONS

For the purpose of this specification the following definitions apply:

Air Gap Method means a clear vertical separation between the pressurized potable water supply and a non-pressurized, non-potable water receiving vessel.

Backflow Prevention means a device used to protect potable water supplies from contamination or pollution due to backflow.

Cleaning means suction and vacuuming removal of debris within culverts, wall drains, pipe sewers, catch basins, maintenance holes, ditch inlets, and oil/grit separators.

Combination Hydro-Jet Cleaner means a service vehicle or equipment capable of pressure washing, suction vacuum cleaning of debris.

Contaminant means contaminant as defined in the E.P.A R.S.O 1990.c E.19

Debris means, dirt, sand, gravel, rocks, bricks, other solid and semi-solid materials, and roots, grease, and encrustations and other materials that may cause restriction to flow in culverts, wall drains, pipe sewers, catch basins, maintenance holes, ditch inlets, and oil/grit separators.

Drainage System Components means the components required to collect and convey the stormwater and include culverts, wall drains, pipe sewers, catch basins, maintenance holes, ditch inlets, wall drains and oil/grit separators.

Flushing means hydraulic pressure washing using various nozzles, pressure and flow rates to flush debris within pipe sewer systems downstream.

Oil/Grit Separator means a hydrodynamic separator, an underground storage device designed to separate oil and suspended solids from stormwater.

Pipe Culvert means as defined in OPSS 421.

Pipe Sewer means as defined in OPSS 410.

Receiving Site means a municipal sanitary sewer or sewage treatment plant, certified waste treatment facility, or certified waste disposal site.

Wall Drain means pipe system used to transmit water from the backfill through the wall structure into the drainage system to alleviate hydrostatic pressure on the wall and prevent erosion underneath and around the road due to unattended water overflow.

411.04 DESIGN AND SUBMISSION REQUIREMENTS

411.04.01 Submission Requirements

When equipment requiring an environmental compliance approval for a waste management system, issued by the Ontario Ministry of the Environment, Conservation and Parks, will be used for the work, a copy of the environmental compliance approval shall be submitted to the Contract Administrator a minimum of 14 Days prior to commencement of the work.

Any approvals, releases, and agreements that are required for the management of cleanout material shall be obtained.

The conditions of the site and the pipe sewer system shall be thoroughly assessed, including the degree of pipe blockage and types of debris. The equipment, nozzles, flow rates, and pressures necessary to complete the work shall be determined. Any supplemental information regarding the sewer network and the assessment method shall be as specified in the Contract Documents.

The proposed cleaning method and procedures, including method to manage effluent and cleanout material shall be submitted to the Contract Administrator at least 14 Days prior to commencing work.

The Contract Administrator shall be notified of the location where cleaning will be performed a minimum of 24 hours in advance of commencing the work.

411.04.01 Permission and Release of Operators of Receiving Sites

Written permission shall be obtained from the operator of a receiving site, prior to its use for disposal of the cleanout material. A copy of this permission shall be provided to the Contract Administrator a minimum of 14 Days prior to the commencement of such work.

411.05 MATERIALS

411.05.01 Water Source

Water source shall be as specified in the Contract Documents. When the source is not specified, water shall be clean and free from oil, acid, alkali, organic matter, or other deleterious substances.

Backflow prevention and air gap methods shall be used when water is taken from potable water systems.

411.06 EQUIPMENT

411.06.01 Combination Hydro-Jet Cleaner

A combination hydro-jet cleaner specifically designed for the purpose of cleaning culverts, wall drains, pipe sewers, catch basins, maintenance holes, ditch inlets, oil/grit separators, and similar facilities, using a selection of nozzles and attachments to permit reaming and root cutting as required, shall be used for the work. The equipment shall be able to clear blockages and remove debris from pipe sewer systems with varied sizes and downstream constraints.

411.07 CONSTRUCTION

411.07.01 General

The conditions of the site and the pipe sewer system shall be thoroughly assessed prior to work commencement, including the degree of pipe blockage and types of debris.

The work shall commence at the upstream end of pipe sewer systems and progress to the downstream end.

Prior to using any mechanical equipment in pipe sewer systems, Utility locates shall be obtained.

Water flow volumes and pressures shall not cause damage to the pipe sewer system or flooding of property. Water flow volumes and pressures shall be appropriate for the age and condition of the pipe sewer system.

Debris that cannot be removed by flushing shall be loosened and broken up using reamers and root cutters as required.

No blockage to service connections or laterals shall occur as a result of the cleaning and flushing or cleanout operation.

Protection of waterbodies and waterbody banks shall be as specified in the Contract Documents.

When beaver dam removal is required within culvert cleanout operations, the beaver dam removal shall be performed according to MTO Best Management Practice for Beaver Dam Removal as specified in MTO Environmental Guide for Fisheries – Best Management Practices Manual.

For post installation inspections, pipe culverts and pipe sewers requiring cleaning and flushing shall be as specified in the Contract Documents.

The Owner may request additional documentation of findings after cleaning and flushing operations as specified in the Contract Documents.

During the cleaning operation, any encountered defects of the drainage system components shall immediately be reported to the Contract Administrator.

The road surface immediately above the culvert shall be monitored during cleanout operations. If any visual inspection indicates that pavement or embankment sinkholes are developing during cleaning or flushing operation, the work shall stop immediately and be reported to the Contract Administrator.

Any damage caused to the existing drainage system components surfaces resulting from the cleaning operations shall be reported to the Contract Administrator and repaired at no additional cost to the Owner.

411.07.02 Culvert Cleaning

Pipe culverts shall be cleaned out to the bottom of the pipe, unless otherwise directed by the Contract Administrator or as specified in the Contract Documents.

Open footing concrete culvert shall be cleaned out to the level of the top of footing and closed box concrete culvert shall be cleaned out to the bottom slab level, unless otherwise directed by the Contract Administrator or as specified in the Contract Documents.

All works within a watercourse shall be conducted in the dry. The surface waters of the watercourse shall be protected from the entry of any disturbed sediment or other debris. Dewatering shall be according to OPSS 517. The work shall include capturing and collecting of all removed sediment or other debris. When sediment control measures are found ineffective immediate changes shall be made.

The culvert shall be considered clean when all debris, including vegetation at the inlet and outlet that obstructs the flow, sand, or silt has been removed from the top, side and bottom (invert) of the culvert.

411.07.03 Culvert and Wall Drain Cleaning by Pressure Washing

The pressure wash cleaning equipment with less than 3,000 PSI pressure at the nozzle shall be used for removal of the corrosion deposits buildup in concrete culverts, around the existing wall drains and cleaning the clogged wall drains. The pressure washer shall be operated at a distance of 150 mm to 300 mm from the surface.

Pressure washing shall not be allowed when ambient temperatures are less than 4 °C.

Chemical cleaning compounds shall not be allowed during pressure washing operations.

During the cleaning operation, any encountered culvert defects shall immediately be reported to the Contract Administrator.

Scraping hand tools may be used to locally remove heavy leachate deposits. Upon the completion of the pressure wash cleaning, any standing water shall be removed by mopping or air blasting or both.

Local waterbody aggregates shall be removed and reinstated at repair locations to the top of floor slab.

411.07.04 Pipe Sewer Cleaning and Flushing

Flushing shall be used to transport debris from each section of pipe sewer to the downstream maintenance hole or catch basin. Each section of pipe sewer between maintenance holes, catch basins,

and ditch inlets shall be cleaned and flushed before cleaning and flushing the next downstream section. Debris shall be continuously cleaned from the downstream maintenance hole or catch basin as flushing occurs.

The passage of debris from one section of pipe sewer to another shall not be permitted, unless specified in the Contract Documents. A weir or sediment trap shall be placed in the maintenance hole to prevent passage of debris from the upstream pipes. When cleaning and flushing is completed for each section, the weir or sediment trap shall be removed.

Cleaning and flushing shall continue for each section of pipe sewer until no further debris is flushed from the pipe, and the pipe sewer section is free of impediments to flow. A minimum of 90% of the pipe sewer circumference shall be free of debris.

If cleanout cannot be completed due to damaged or broken pipe sewer, catch basin, maintenance hole, or ditch inlet, the Contract Administrator shall be immediately notified.

411.07.05 Catch Basin, Maintenance Hole, and Ditch Inlet Cleanout

A combination hydro-jet cleaner shall remove debris from catch basins, maintenance holes, and ditch inlets separately.

411.07.06 Oil/Grit Separator Cleanout

Oil/Grit separators shall be cleaned out by closing or blocking off the inlet and outlet pipes, dewatering the system, removal of debris by vacuum or other mechanical means, and cleaning and flushing to remove sediment. The inlet and outlet pipes shall not be reopened or unblocked until after the separator has been inspected by the Contract Administrator.

411.07.07 Closed-Circuit Television Inspection

When specified in the Contract Documents, pipe culverts and pipe sewers shall be inspected after cleaning by closed-circuit television (CCTV) according to OPSS 409. The Contract Administrator shall be notified a minimum 24 hours prior to the inspection.

When specified in the Contract Documents, water shall be added immediately prior to CCTV inspection to the upstream end of the pipe culvert and pipe sewer system for minimum flow to the system low point by gravity.

411.07.08 Management of Cleanout Material

Cleanout material shall be inspected to identify the presence of any visual, olfactory, or other evidence of the spill of a contaminant. Material that is found during cleanout to be impacted by a spill of a contaminant shall be managed as specified in the Contract Documents.

Debris removed from culverts, pipe sewers, catch basins, maintenance holes, ditch inlets, and oil/grit separators shall be managed as cleanout material as specified in the Contract Documents.

The cleanout material shall be managed by one, or a combination of, the following:

a) as a composite material without dewatering; or

b) by dewatering and subsequent management of sludge component.

A copy of the weigh tickets or receipts provided by the site operator shall be submitted to the Contract Administrator. Where such documentation is not available, written confirmation that the waste has been

received shall be obtained from the owner of the disposal site, and provided to the Contract Administrator, a maximum of 14 Days after disposal activities are complete.

411.07.08.01 Management as a Composite Material Without Dewatering

When cleanout is done without dewatering, the composite material shall be managed as non-hazardous solid industrial or commercial waste and shall be transported from the area designated for cleanout directly to one of the following:

a) a landfill site with an environmental compliance approval/certificate of approval for a disposal site valid for commercial and municipal waste;

b) a waste treatment facility with an environmental compliance approval/certificate of approval for a waste disposal site (processing), or a certificate of approval for waste disposal site (mobile processing) valid for commercial or municipal waste.

411.07.08.02 Dewatering and Subsequent Management of Sludge Component

Cleanout material shall be dewatered as necessary. Dewatering shall be by discharge of the liquid component of cleanout material directly to one or a combination of the following:

a) a waste treatment facility with an environmental compliance approval/certificate of approval for a waste disposal site (processing), or a certificate of approval for a waste disposal site (mobile processing), valid for commercial or municipal waste;

b) the culvert, pipe sewer or ditch from which the material was removed.

The sludge or solid component of the cleanout material shall be managed as non-hazardous solid industrial waste or commercial waste and shall be transported directly, with the exception of dewatering en route, from the area designated for cleanout to a certified receiving site.

Transportation of the cleanout material shall be done by a hauler with a certificate of approval for a waste management system that is valid for the following:

a) the entire work period;

b) the entire area within the limits of the work and the entire haul route;

c) the equipment to be used, and

d) non-hazardous solid industrial waste, or commercial waste.

411.09 MEASUREMENT FOR PAYMENT

411.09.01 Actual Measurement

411.09.01.01 Cleanout of Pipe Sewer

Measurement shall be in metres and along the centreline of the pipe sewer from the centre of the maintenance hole, catch basin, ditch inlet or oil/grit-separator at each end of the pipe sewer system to be cleaned out.

When cleaning and flushing is incomplete due to a collapsed pipe or immovable blockage, the length of collapsed pipe or blockage shall be deducted from the length measured for payment.

411.09.01.02 **Cleanout of Culvert**
Cleanout of Wall Drain
Cleanout of Cleanout of Catch Basin
Cleanout of Maintenance Hole
Cleanout of Ditch Inlet
Cleanout of Oil/Grit Separator

For measurement purposes, a count shall be made of the number of structures cleaned.

411.09.02 **Plan Quantity Measurement**

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clause under Actual Measurement.

411.10 **BASIS OF PAYMENT**

411.10.01 **Cleanout of Culvert – Item**
Cleanout of Wall Drain – Item
Cleanout of Pipe Sewer – Item
Cleanout of Catch Basin– Item
Cleanout of Maintenance Hole – Item
Cleanout of Ditch Inlet – Item
Cleanout of Oil/Grit Separator – Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to complete the work.

Payment for the management of material found, during the cleanout operation, to be contaminated by the spill of a contaminant shall be treated as a Change in the Work.

Any costs incurred due to delays in obtaining the approvals, releases, agreements or verifications required to complete the work as specified in the Contract, shall be borne by the Contractor at no additional cost to the Owner.

Appendix 411-A, November 2021
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

The designer should specify the following in the Contract Documents:

- The owner shall provide any available information on the condition of the sewer network (e.g., size, age, constraints, material, known defects, vulnerable sections). (411.04)

- Water source. (411.05.01)

- The owner may choose to evaluate, specify or approve the assessment method of pipe prior to work. (411.07.01). (411.07.01)

- If access to the waterbody or a waterbody bank is required, necessary protection measures shall be specified. (411.07.01)

- For post installation inspections, the owner shall identify sewers requiring flushing and cleaning. (411.07.01)

- The individual owners may request documentation of findings after flushing completion (e.g., presence of grease, roots, construction debris, pipe defect and; an estimate of the light/medium/heavy level of material removed, where applicable; and submission of inspection reports and maps). (411.07.01)

- Beaver dam removal is required within culvert cleanout operations. (411.07.01)

- Pipe culvert cleaning. (411.07.02)

- Concrete culvert cleaning. (411.07.02)

- The owner shall identify if passing material between maintenance holes will be permitted. (411.07.02)

- The owner shall designate if CCTV inspection is not required. (411.07.07)

- The owner shall designate if additional water for minimum flow is required prior to the camera inspection. (411.07.07)

- The owner shall designate water source where applicable including any metering or tracking if required. (411.07.07)

- The owner shall designate disposal sites where applicable, designating as temporary or permanent, as necessary, including any additional environmental requirements. (411.07.08)

Related Ontario Provincial Standard Drawings

No information provided here.

CONSTRUCTION SPECIFICATION FOR FORCEMAIN INSTALLATION IN OPEN CUT

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412-A **Commentary**

412.01 SCOPE

This specification covers the requirements for the installation of Forcemains and associated appurtenances in open cut.

412.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

412.01.02 Appendices Significance and Use

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This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 206	Grading
OPSS 401	Trenching, Backfilling, and Compacting
OPSS 404	Support Systems
OPSS 490	Site Preparation for Pipelines, Utilities, and Associated Structures
OPSS 491	Preservation, Protection, and Reconstruction of Existing Facilities
OPSS 492	Site Restoration Following Installation of Pipelines, Utilities, and Associated Structures
OPSS 517	Dewatering of Pipeline, Utility, and Associated Structure Excavation
OPSS 539	Temporary Protection Systems

Ontario Provincial Standard Specifications, Material

OPSS 1004	Aggregates - Miscellaneous
OPSS 1301	Cementing Materials
OPSS 1302	Water
OPSS 1350	Concrete - Materials and Production
OPSS 1842	Pressure Polyethylene Pipe Products

CSA Standards

B137.1-09	Polyethylene (PE) Pipe, Tubing, and Fittings for Cold Water Pressure Services [Part of B137 Series-09, Thermoplastic Pressure Piping Compendium]
B137.2-09	Polyvinylchloride (PVC) Injection-Moulded Gasketed Fittings for Pressure Applications [Part of B137 Series-09, Thermoplastic Pressure Piping Compendium]

B137.3-09 Rigid Polyvinylchloride (PVC) Pipe and Fittings for Pressure Applications [Part of B137 Series-09, Thermoplastic Pressure Piping Compendium]

ASTM International

A 153/A 153M-09	Zinc Coating (Hot-Dip) on Iron and Steel Hardware
A 276-15	Stainless Steel Bars and Shapes
A 307-14	Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
B 633-13	Electrodeposited Coatings of Zinc on Iron and Steel
B 766-86 (2015)	Electrodeposited Coatings of Cadmium
C 361-14a	Reinforced Concrete Low-Head Pressure Pipe (Metric)
D 3139 (2011)	Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals

American Water Works Association (AWWA)

C104/A21.3-08	Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
C110/A21.10-12	Ductile-Iron and Gray-Iron Fittings for Water
C111/A21.11-12	Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
C151/A21.51-09	Ductile-Iron Pipe, Centrifugally Cast**,** for Water
C153/A21.53-11	Ductile-Iron Compact Fittings for Water Service
C200-12	Steel Water Pipe - 6 in. (150 mm) and Larger
C205-12	Cement-Mortar Protective Lining and Coating for Steel Water Pipe - 4 in. (100 mm) and Larger, Shop Applied
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C302-11	Reinforced Concrete Pressure Pipe, Noncylinder Type
C303-11	Concrete Pressure Pipe, Bar-Wrapped, Steel-Cylinder Type
C504-10	Rubber-Seated Butterfly Valves
C509-09	Resilient-Seated Gate Valves for Water Supply Service

American Society of Mechanical Engineers (ASME)

B18.2.1-96 (R2010)	Square and Hex Bolts and Screws - Inch Series

412.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Associated Appurtenance means structures, devices, and appliances, other than pipe and conduit that are used in connection with a forcemain, such as valves and thrust restraints.

Backfilling means as defined in OPSS 401.

Excavation, Earth and Rock means the excavation classified as earth and rock according to OPSS 206.

Fitting means connections, appliances, and adjuncts designed to be used in connection with pipes (e.g., elbows and bends to alter the direction of a pipe; tees and crosses to connect a branch with a sewer main; plugs and caps to close a pipe end; and bushings, diminishers, or reducers to couple two pipes of different diameters).

Forcemain means an installation designed for the conveyance of sanitary or storm sewage under pressure, using pre-formed or pre-cast circular pipe sections that are laid end to end and joined using suitable methods.

412.05 MATERIALS

412.05.01 General

Pipe size, material, and class shall be according to the requirements specified in the Contract Documents.

Fittings shall be suitable for and compatible with the pipe size, material, and class with which they will be used.

412.05.02 Ductile Iron Pipe

Ductile iron pipe shall be according to AWWA C151/A21.51.

Fittings shall be gray iron according to AWWA C110/A21.10 or ductile iron according to AWWA C 110/A21.10 or AWWA C153/A21.53.

Ductile iron pipe and fittings shall be cement lined according to AWWA C104/A21.3.

Rubber gaskets for push-on or mechanical joints shall be according to AWWA C111/A21.11.

412.05.03 Concrete Pressure Pipe

Concrete cylinder pipe, including joints and fittings, shall be according to AWWA C301 or AWWA C303.

Non-cylinder pipe and joints shall be according to AWWA C302 or ASTM C 361. Fittings shall be according to AWWA C302.

412.05.04 Polyvinyl Chloride (PVC) Pressure Pipe

Polyvinyl chloride pressure pipe and fittings shall be according to CSA B137.3 and supplied from a plant approved by an organization accredited by the Standards Council of Canada (SCC).

Flexible elastomeric seals for bell and spigot joints shall be according to ASTM D 3139.

Fittings shall be either:

a) Gray iron according to AWWA C110/A21.10.

b) Ductile iron according to AWWA C110/A21.10 or AWWA C153/A21.53 and cement lined according to AWWA C104/21.4.

c) Injection moulded polyvinyl chloride plastic according to CSA B137.2.

d) Prefabricated polyvinyl chloride plastic for pipe diameters 200 mm and larger according to CSA B137.3.

412.05.05 Polyethylene (PE) Pressure Pipe

Polyethylene pressure pipe shall be according to OPSS 1842.

Fittings shall be either:

a) Flanged gray iron according to AWWA C110/A21.10.

b) Flanged ductile iron according to AWWA C110/A21.10 or AWWA C153/A21.53 and cement lined according to AWWA C104/A21.4.

c) Polyethylene according to OPSS 1842.

d) Heat fusion or insert or compression type fittings according to CSA B137.1.

412.05.06 Steel Pipe

Steel pipe shall be according to AWWA C200.

Fittings shall be according to AWWA C208.

Steel pipe shall have a cement-mortar protective lining and coating according to AWWA C205.

412.05.07 Valves

412.05.07.01 General

All valves shall open by operating in a counter clockwise direction, or as specified in the Contract Documents.

Valves shall be designed for a minimum cold water working pressure of 1,035 kPa.

Valve types shall be one of the following:

a) Valves less than 75 mm shall be brass or bronze gate valves.

b) Valves greater than or equal to 75 mm and less than or equal to 300 mm shall be cast iron or ductile iron gate valves.

c) Valves greater than 300 mm up to and including 500 mm shall be gate or butterfly valves.

d) Valves greater than 500 mm shall be butterfly valves.

e) Knife gate valves shall be installed when specified in the Contract Documents.

Fasteners shall be made from material meeting the strength requirements of ASTM A 307 with dimensions according to ASME B18.2.1. Bolts, studs, and nuts shall be cadmium plated according to ASTM B 766 or zinc coated according to ASTM A 153/A 153M or ASTM B 633. Fasteners for mechanical joints shall be ductile iron according to AWWA C111/A21.11.

412.05.07.02 Gate Valves

Gate valves shall be according to AWWA C509.

Stem sealing on non-rising stem valves shall use O-Ring type seals that do not require adjustment. The end configuration shall be as specified in the Contract Documents.

412.05.07.03 Butterfly Valves

Butterfly valves shall be according to AWWA C504.

Valves shall be short body flanged or mechanical-joint, class 150B.

Valve shafts shall be stainless steel, and when they project through the body, shall have seals that do not require adjustment.

A vertical operating nut shall be provided. Valves shall be provided with an external indicator showing valve position by means of a pointer operating through a 90° arc from open to close.

412.05.07.04 Knife Gate Valves

Valves shall be made of Type 304 or Type 316 stainless steel.

Valves shall have full port area and wafer face to face. The valves shall have face to face welded parts, including packing chest and packing stuffer and stem, complete with a resilient seat.

412.05.07.05 Air Release and Air/Vacuum Valves

Air release and air/vacuum valves shall be single acting type.

412.05.08 Concrete

Concrete for thrust blocks and fitting and appurtenance supports shall be according to OPSS 1350 with a nominal minimum 28-Day compressive strength of 20 MPa.

412.05.09 Mortar

Mortar for joints shall consist of one part Portland cement and three parts mortar sand, and wetted with sufficient water to the consistency of a thick cream. The mortar sand shall be according to OPSS 1004, the Portland cement shall be according to OPSS 1301, and the water shall be according to OPSS 1302.

412.05.10 Stainless Steel Straps, Tie-Rods, Angles, Nuts, and Bolts

Stainless steel straps, tie-rods, angles, nuts, and bolts used with concrete thrust blocks shall be according to ASTM A 276, Type 316 stainless steel.

412.07 CONSTRUCTION

412.07.01 Site Preparation

Site preparation shall be according to OPSS 490.

412.07.02 Preservation and Protection of Existing Facilities

Preservation and protection of existing facilities shall be according to OPSS 491.

412.07.03 Protection Against Floatation

Damage to the pipeline due to floatation shall be prevented during construction and until completion of the work.

412.07.04 Cold Weather Work

All work shall be protected from freezing. Pipes and bedding material shall not be installed on frozen ground.

412.07.05 Transporting, Unloading, Storing, and Handling Pipe

Manufacturer's recommendations for transporting, unloading, storing, and handling of pipe shall be followed.

All pipes, fittings, and gaskets that are unsound or damaged shall be rejected.

412.07.06 Excavation

Excavation for placing forcemains shall be according to OPSS 401.

412.07.07 Support Systems

Support systems shall be according to OPSS 404.

412.07.08 Dewatering

Dewatering shall be according to OPSS 517.

412.07.09 Temporary Protection Systems

The construction of all temporary protection systems shall be according to OPSS 539. When the stability, safety, or function of an existing roadway, railway, other works, or proposed works may be impaired due to the method of construction, such protection as may be required shall be provided. Protection may include sheathing, shoring, and the driving of piles, where necessary, to prevent damage to such works or proposed works.

412.07.10 Backfilling and Compacting

Backfilling and compacting shall be according to OPSS 401.

412.07.11 Installation of Pipe

Pipe shall be laid in a dry trench.

Ends of pipe shall be kept clean.

Pipe shall be laid within the alignment and grade tolerances specified in the Contract Documents. The barrel of each pipe shall be in contact with the shaped bed throughout its full length.

Pipe shall be kept clean as work progresses. Water shall not be allowed to flow through the pipe during construction. A removable watertight bulkhead shall be installed at the open end of the last pipe laid whenever work is suspended.

Pipe shall not be laid until the preceding pipe joint has been completed and the pipe carefully embedded and secured in place.

412.07.12 Jointing

412.07.12.01 General

Joint surfaces shall be clean. Pipe ends shall be lubricated with material recommended by the pipe manufacturer.

Manufacturer's instructions for jointing pipes shall be followed.

Joints and all connections shall be made watertight.

All bolts, nuts, couplings, rubber rings, and connecting pieces shall be cleaned thoroughly prior to installation.

Pipes shall be aligned on centreline to previously laid pipe.

Pipe shall be pulled or pushed into the previously laid pipe by hand or by a hand operated winch. A backhoe or other equipment shall not be used to push the pipe.

Joints shall be prevented from opening after the pipe has been laid.

412.07.12.02 Ductile Iron Pipe

412.07.12.02.01 Mechanical Joints

The gland shall be positioned on the pipe with the lip extension toward the joint. The gasket shall be slipped on the pipe with the thick edge towards the gland. The spigot end shall be pushed to its seat in the bell. The gasket shall be pressed to seat it evenly around the joint.

The gland shall be positioned for bolting and the bolts shall be inserted. All nuts shall be hand tightened.

The nuts shall be tightened half a turn at a time with a calibrated torque wrench. All nuts shall be tightened uniformly to the torque specified in AWWA C111/A21.11.

412.07.12.02.02 Bell and Spigot Joints

The gasket shall be lubricated and placed in the groove of the bell making certain it is properly seated.

Pipes to be joined shall be aligned and the spigot shall be carefully entered into the bell until the spigot end just makes contact with the gasket.

The entry of the spigot into the bell shall continue until the second reference mark is flush with the face of the bell.

412.07.12.03 Concrete Pressure Pipe

412.07.12.03.01 Bell and Spigot Joints

A cotton or burlap diaper shall be placed around the bell end of the pipe already in place.

A rubber gasket shall be placed on the spigot end of the pipe to be laid ensuring that the stretch and volume of the gasket is equalized around the entire circumference of the pipe. The gasket and spigot shall be lubricated prior to the spigot end being inserted home into the bell end.

The pipe shall be aligned and the spigot end shall be inserted into the bell of the pipe already in place. Steel inserts shall be placed in the joints to prevent the spigot from entering the full depth of the bell. The location of the rubber gasket shall be checked around the entire circumference of the joint. The steel insert shall be removed and the pipe pushed until the spigot enters the full depth of the socket and is retained in position.

The diaper shall be carefully placed around the joint recess. Cement mortar shall be poured around the assembled joint.

412.07.12.04 Polyvinyl Chloride (PVC) Pressure Pipe

Joints shall be bell and spigot with rubber gaskets. If gaskets are supplied separately, they shall be inserted in the groove of the bell end of the pipe.

The spigot shall be lubricated. The spigot end shall be inserted and pushed into the bell until the second reference mark is flush with the face of the bell.

412.07.12.05 Polyethylene (PE) Pressure Pipe

Polyethylene pressure pipe 100 mm diameter and larger shall be joined by the thermal butt fusion process. Procedures recommended by the pipe manufacturer shall be followed.

Polyethylene pressure pipe that is smaller than 100 mm shall be joined with heat fusion or insert or compression type fittings that are recommended by the pipe manufacturer and that prevent pull out and resist creep deformation at full test pressure.

Connections to non-polyethylene fittings and appurtenances that are 50 mm diameter and larger shall be made with flanged joints according to manufacturer's recommendations. Bolts shall be tightened to the torque specified by the manufacturer for the particular size and type of stub end.

412.07.12.06 Steel Pipe

Steel pipe shall be jointed according to AWWA C200. Field welding for joints shall be according to AWWA C206.

412.07.13 Cutting of Pipe

Whenever cutting of pipe is required, the pipe shall be cut according to the recommendations of the pipe manufacturer.

412.07.14 Change in Line and Grade

412.07.14.01 Ductile Iron Pipe

Fabricated bends shall be provided for changes in line and grade of 11.25° or more.

Deflections of less than 11.25° may be made using a series of pipe joint deflections. The manufacturer's recommendation in deflecting any single pipe joint shall not be exceeded.

412.07.14.02 Concrete Pressure Pipe

Fabricated bends, bevel adapters, or elbows shall be used for changes in line or grade greater than 5°. Changes in line or grade less than 5° shall be made using a manufactured joint or bevel connection or may be made over several joints, but at no time shall the manufacturer's joint deflection recommendations be exceeded.

412.07.14.03 Polyvinyl Chloride (PVC) Pressure Pipe

Polyvinyl chloride pressure pipe joints may be deflected, but shall not exceed manufacturer's recommendations. Otherwise, fabricated bends shall be used.

412.07.14.04 Polyethylene (PE) Pressure Pipe

Use of pipe flexibility may be allowed, but shall not exceed manufacturer's recommendations.

412.07.14.05 Steel Pipe

Fabricated bends shall be used at all changes in line or grade, unless the change can be accomplished by deflections at pipe joints without exceeding the manufacturer's recommendations for deflection at pipe joints.

412.07.15 Installation of Valves

412.07.15.01 General

The work of installing valves shall include the valves and couplings, and when specified in the Contract Documents, valve boxes. Valves shall be installed in locations and of the type specified in the Contract Documents. Valves and connecting pipes shall be aligned accurately and supported as specified in the Contract Documents.

412.07.15.02 Air Release and Air/Vacuum Valves

Air release and air/vacuum valves shall be installed at locations specified in the Contract Documents.

Each air release and air/vacuum valve shall be provided with an isolating valve.

412.07.16 Thrust Restraints

All connections, caps, and bends shall be restrained by concrete blocking or restrained joints as specified in the Contract Documents. Concrete for thrust blocks shall be placed against undisturbed ground. Joints and couplings shall remain free from concrete.

412.07.17 Hydrostatic Testing

412.07.17.01 General

Hydrostatic testing shall be conducted under the supervision of the Contract Administrator.

A test section shall be either a section between valves or the completed forcemain. The forcemain that is to be tested shall be backfilled before testing commences.

Test pressure shall be as specified in the Contract Documents.

The test section shall be filled slowly with water and all air shall be removed from the pipeline. A 24-hour absorption period may be allowed before starting the test. The test section shall be subjected to the specified continuous test pressure for two hours.

412.07.17.02 Polyethylene (PE) Pressure Pipe

The test procedure shall consist of initial expansion and test phases.
During the initial expansion phase, the test section shall be pressurized to the test pressure, and sufficient make-up water shall be added each hour for 3 hours to return to the test pressure. After the initial expansion phase, the test phase begins.

The test phase shall be 2 hours after which a measured amount of make-up water is added to return the test pressure. If the amount of make-up water added does not exceed the value in Table 1, leakage is not indicated. If the amount of make-up water exceeds the Table 1 value, all leaks shall be located and repaired and the test section shall be retested until a satisfactory result is obtained.

The test procedure duration should not exceed 8 hours. If the pressure test is not completed, the test section shall be de-pressurized and allowed to relax for at least 8 hours prior to bringing the test section up to pressure again.

412.07.17.03 Other Pipe

The test section shall be subject to the specified continuous test pressure for 2 hours.

The leakage shall be the amount of water added to the test section to maintain the specified test pressure for the test duration. The measured leakage shall be compared with the allowable leakage as calculated for the test section. The allowable leakage shall be 0.082 litres per millimetre of pipe diameter per kilometre of pipe for the 2 hour test period.

If the measured leakage exceeds the allowable leakage, all leaks shall be located and repaired and the test section shall be retested until a satisfactory result is obtained.

412.07.18 Cleaning and Flushing Forcemains

All forcemains shall be cleaned and flushed.

412.07.19 Site Restoration

Site restoration shall be according to OPSS 492.

412.07.20 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

412.09 MEASUREMENT FOR PAYMENT

412.09.01 Actual Measurement

412.09.01.01 Forcemains

Measurement of forcemains shall be by length in metres horizontally along the centreline of the pipe from the existing point of connection to a point vertically above the end of the new forcemain.

412.09.01.02 Valves

For measurement purposes, a count shall be made of the number of valves installed regardless of the type or size.

412.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

412.10 BASIS OF PAYMENT

412.10.01 Forcemains - Item
Valves - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

When the Owner raises or lowers the invert of a forcemain by up to 150 mm, it will not constitute a Change in the Work and no adjustment shall be made to the payment. When the invert of a forcemain is raised or lowered by 150 mm or more, this shall then constitute a Change in the Work for the full extent of the change from the original grade.

TABLE 1
Test Phase Make-Up Amount for Pressure Polyethylene Pressure Pipe

Pipe Diameter Mm	Make-Up Water litre/km
30	12.38
40	12.38
50	13.62
75	18.60
100	31.00
150	74.50
200	124.20
250	161.40
275	248.30
300	285.60
350	335.20
400	409.70
450	533.90
500	682.90
550	869.10
600	1,105.00
700	1,378.20
800	1,775.50
900	2,234.90
1,000	2,731.60
1,050	3,104.00
1,200	3,973.20
1,350	5,152.70
1,600	7,449.70

Appendix 412-A, November 2018
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer may consider including soil boring data, a geotechnical report, a subsurface report, or a soils report in the Tender Documents.

The designer should specify the following in the Contract Documents:

- Pipe size, material, and class. (412.05.01)

- Valve opening instruction if needed (412.05.07.01)

- Gate valve end configuration. (412.05.07.02)

- Alignment and grade tolerances for the pipe installation. (412.07.11)

- Valve type, location, and support. (412.07.15.01)

- Location of air release and air/vacuum valves. (412.07.15.02)

- Type of thrust restraints. (412.07.16)

- Test pressure for hydrostatic testing. (412.07.17.01)

The requirement for valve boxes should be determined. If they are required, they should be specified in the Contract Documents. (412.07.15.01)

Corrosion protection system provisions should be specified, if appropriate.

Tracer wire and marker tape should be specified if appropriate. Designer may wish to add identifier codes or markings to identify the use of the pipe (e.g., sanitary or storm vs. watermain or gas).

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 1103.010	Concrete Thrust Blocks for Tees, Plugs, and Horizontal Bends
OPSD 1103.020	Concrete Thrust Blocks for Vertical Bends

CONSTRUCTION SPECIFICATION FOR MANURE PIPELINE INSTALLATION IN OPEN CUT

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413.01 **SCOPE**

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413.04 **DESIGN AND SUBMISSION REQUIREMENTS - Not Used**

413.05 **MATERIALS**

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413.07 **CONSTRUCTION**

413.08 **QUALITY ASSURANCE - Not Used**

413.09 **MEASUREMENT FOR PAYMENT**

413.10 **BASIS OF PAYMENT**

APPENDICES

413-A **Commentary**

413.01 SCOPE

This specification covers the requirements for installing permanent manure pipelines in open cut.

413.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

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D 3139-98 (2011)	Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals

American Water Works Association (AWWA)

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C153/A21.53-11	Ductile-Iron Compact Fittings
C509-09	Resilient-Seated Gate Valves for Water-Supply Service

American Society of Mechanical Engineers (ASME)

B18.2.1-2012	Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series), Includes Errata (2013)

413.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Backfilling means as defined in OPSS 401.

Excavation, Earth and Rock means the excavation classified as earth and rock according to OPSS 206.

Fitting means connections, appliances, and adjuncts designed to be used in connection with pipes. Examples are: elbows and bends to alter the direction of a pipe; tees and crosses to connect a branch with a sewer main; plugs and caps to close a pipe end; and bushings, diminishers, or reducers to couple two pipes of different diameters.

Manure Pipeline means an installation designed for the conveyance of liquid manure under pressure using circular pipe.

413.05 MATERIALS

413.05.01 General

Pipe size shall be according to the requirements specified in the Contract Documents. Pipe material and class shall be as specified in the Contract Documents.
Pipe smaller than 100 mm in diameter shall not be used.

Fittings shall be suitable for and compatible with the pipe material and class with which they will be used.

413.05.02 Polyvinyl Chloride Pipe Products

Polyvinyl chloride pipe and fittings shall be according to CSA B137.3 and supplied from a plant approved by an organization accredited by the Standards Council of Canada.

Flexible elastomeric seals for bell and spigot joints shall be according to ASTM D 3139.

Fittings shall be either:

a) gray iron according to AWWA C110/A21.10;

b) ductile iron according to AWWA C110/A21.10 or AWWA C153/A21.53, and shall be cement lined according to AWWA C104/A21.4;

c) injection moulded polyvinyl chloride according to CSA B137.2; or

d) prefabricated polyvinyl chloride pipe diameters 200 mm and larger according to CSA B137.3.

413.05.03 Polyethylene Pipe Products

Polyethylene pressure pipe shall be according to OPSS 1842.

Fitting shall be either:

a) flanged gray iron according to AWWA C110/A21.10;

b) flanged ductile iron according to AWWA C110/A21.10 or AWWA C153/A21.53 and shall be cement lined according to AWWA C104/A21.4; or

c) polyethylene according to OPSS 1842.

Ductile iron pipe and fittings shall be cement lined according to AWWA C104/A21.4.

413.05.04 Valves

413.05.04.01 General

All valves shall open by operating in a counter-clockwise direction.

Valves shall be designed for a minimum cold water working pressure of 1,035 kPa.

Valves shall be cast or ductile iron gate valves.

Fasteners shall be made from material meeting the strength requirements of ASTM A 307 with dimensions according to ANSI ASME B18.2.1. Bolts, studs, and nuts shall be cadmium plated according to ASTM B 766 or zinc coated according to ASTM A 153M or ASTM B 633. Fasteners for mechanical joints shall be ductile iron according to AWWA C111/A21.11.

413.05.04.02 Gate Valves

Gate valves shall be according to AWWA C509.

Stem sealing on non-rising stem valves shall utilize O-ring type seals that do not require adjustment.

The gate valve end configuration shall be as specified in the Contract Documents.

413.05.04.03 Air Release and Air/Vacuum Valves

Air release and air/vacuum valves shall be sewage type.

413.05.05 Risers

Riser type shall be as specified in the Contract Documents.

413.05.06 Concrete

Concrete for thrust blocks and fitting and appurtenance supports shall be according to OPSS 1350 with a nominal minimum 28-Day compressive strength of 20 MPa.

413.05.07 Straps, Tie-Rods, Angles, Nuts, and Bolts

Stainless steel straps, tie-rods, angles, nuts, and bolts used with concrete thrust blocks shall be according to ASTM A 276, Type 316 stainless steel.

413.07 CONSTRUCTION

413.07.01 Site Preparation

Site preparation shall be according to OPSS 490.

413.07.02 Preservation and Protection of Existing Facilities

Preservation and protection of existing facilities shall be according to OPSS 491.

413.07.03 Protection Against Floatation

Damage to the pipeline due to floatation shall be prevented during construction and until completion of the work.

413.07.04 Cold Weather Work

All work shall be protected from freezing. Pipe and bedding material shall not be installed on frozen ground.

413.07.05 Transporting, Unloading, Storing, and Handling Materials

All pipes, fittings, and gaskets that are unsound or damaged shall be rejected.

Manufacturer's recommendations for transporting, unloading, storing, and handling of materials shall be followed.

413.07.06 Excavation

Excavation for the placement of forcemains shall be according to OPSS 401.

413.07.07 Support Systems

Support systems shall be according to OPSS 404.

413.07.08 Dewatering

Dewatering shall be according to OPSS 517.

413.07.09 Temporary Protection Systems

The construction of all temporary protection systems shall be according to OPSS 539. Where the stability, safety, or function of an existing roadway, railway, other works, or proposed works may be impaired due to the method of construction, such protection as may be required shall be provided. Protection may include sheathing, shoring, and the driving of piles where necessary to prevent damage to such works or proposed works.

413.07.10 Installation of Pipe

Pipe shall be laid in a dry trench.

Ends of pipe shall be kept clean.

Pipe shall be laid within the alignment and grade tolerances specified in the Contract Documents. The barrel of each pipe shall be in contact with the shaped bed throughout its full length.

Pipe shall be kept clean and dry as work progresses. A removable watertight bulkhead shall be installed at the open end of the last pipe laid whenever work is suspended.

Pipe shall not be laid until the preceding pipe joint has been completed and the pipe carefully embedded and secured in place.

413.07.11 Jointing

413.07.11.01 General

Joint surfaces shall be clean. Pipe ends shall be lubricated with material recommended by the pipe manufacturer.

Manufacturer’s instructions for jointing of pipe shall be followed.

Joints and all connections shall be made watertight.

All bolts, nuts, coupling, rubber rings, and connecting pieces shall be cleaned thoroughly prior to installation.

Pipe shall be aligned on centreline to previously laid pipe.

Pipe shall be pulled or pushed only by a hand-operated winch. A backhoe shall not be used for pushing pipe.

Joints shall be prevented from opening after the pipe has been laid.

413.07.11.02 Polyvinyl Chloride Pressure Pipe

Joints shall be bell and spigot with rubber gaskets. If gaskets are supplied separately, they shall be inserted in the groove of the bell end of the pipe.

The spigot shall be lubricated. The spigot end shall be inserted and pushed into the bell until the second reference mark is flush with the face of the bell.

413.07.11.03 Polyethylene Pressure Pipe

Polyethylene pipe 100 mm diameter and larger shall be joined by the thermal butt fusion process. Procedures recommended by the pipe manufacturer shall be followed.

Connections to non-polyethylene fittings and appurtenances shall be made with flanged joints according to the manufacturer's recommendations. Bolts shall be tightened to the torque specified by the manufacturer for the particular size and type of stub end.

413.07.12 Cutting of Pipe

Whenever cutting of pipe is required, the pipe shall be cut according to the recommendations of the pipe manufacturer.

413.07.13 Change in Line and Grade

413.07.13.01 Polyvinyl Chloride Pipe

Polyvinyl chloride pressure pipe joints may be deflected, but shall not exceed manufacturer's recommendations. Otherwise, fabricated bends shall be used.

413.07.13.02 Polyethylene Pipe

Use of pipe flexibility may be allowed, but shall not exceed manufacturer's recommendations.

413.07.14 Installation of Valves

413.07.14.01 General

The work of installing valves shall include the valves and couplings, and when specified in the Contract Documents, valve boxes. Valves shall be installed at locations and be of the type specified in the Contract Documents. Valves and connecting pipes shall be aligned accurately and supported as specified in the Contract Documents.

413.07.14.02 Air Release and Air/Vacuum Valves

Air release and air/vacuum valves shall be installed at locations specified in the Contract Documents.

Each air release and air/vacuum valve shall be provided with an isolating valve.

413.07.15 Installation of Riser Sets

The work of installing riser sets shall include the placing of risers, riser isolating valves, riser tees, restraining devices, riser caps, and safety and support devices.

Riser sets shall be installed at locations specified in the Contract Documents.

413.07.16 Thrust Restraints

All connections, caps, and bends shall be restrained by concrete blocking or restrained joints as specified in the Contract Documents. Concrete for thrust blocks shall be placed against undisturbed ground. Joints and couplings shall remain free from concrete.

413.07.17 Backfilling and Compacting

Backfilling and compacting shall be according to OPSS 401.

413.07.18 Hydrostatic Testing

413.07.18.01 General

Hydrostatic testing shall be conducted under the supervision of the Contract Administrator upon completion of the pipeline, including backfilling.

A test section shall be either a section between valves or the completed pipeline.

Test pressure shall be 1,035 kPa.

The test section shall be filled slowly with water and all air shall be removed from the pipeline. A 24-hour absorption period may be allowed before starting the test. The test section shall be subjected to the specified continuous test pressure for two hours.

413.07.18.02 Polyethylene Pipe

The test procedure shall consist of initial expansion and test phases.

During the initial expansion phase, the test section shall be pressurized to the test pressure and sufficient make-up water added each hour for 3 hours to return to test pressure. After the initial expansion phase, the test phase shall begin.

The test phase shall be 2 hours after which a measured amount of make-up water is added to return the test pressure. If the amount of make-up water added does not exceed the values shown in Table 1, leakage is not indicated.

If the amount of make-up water exceeds the values shown in Table 1, all leaks shall be located and repaired and the test section shall be retested until a satisfactory result is obtained.

The test duration should not exceed 8 hours. If the pressure test is not completed, the test section shall be de-pressurized and allowed to relax for 8 hours prior to bringing the test section up to pressure again.

413.07.18.03 Other Pipe

The test section shall be subject to the specified continuous test pressure for 2 hours.

The leakage is the amount of water added to the test section to maintain the specified test pressure for the test duration. The measured leakage shall be compared with the allowable leakage as calculated for the test section. The allowable leakage is 0.082 litres per millimetre of pipe diameter per kilometre of pipe for the 2-hour test period.

If the measured leakage exceeds the allowable leakage, all leaks shall be located and repaired and the test section shall be retested until a satisfactory result is obtained.

413.07.19 Cleaning and Flushing Pipe

All pipe shall be cleaned and flushed.

413.07.20 Site Restoration

Site restoration shall be according to OPSS 492.

413.07.21 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

413.09 MEASUREMENT FOR PAYMENT

413.09.01 Actual Measurement

413.09.01.01 Pipeline

Measurement of pipeline shall be by length in metres along the horizontal centreline of the pipe from the point of connection to portable equipment or existing pipeline to a point vertically above the end of the new pipeline.

413.09.01.02 Valves

For measurement purposes, a count shall be made of the number of valves installed regardless of the type and size.

413.09.01.03 Riser Sets

For measurement purposes, a count shall be made of the number of riser sets installed regardless of the type.

413.09.01.04 Connections to Existing Pipelines

For measurement purposes, a count shall be made of the number of connections to existing pipelines.

413.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

413.10 BASIS OF PAYMENT

413.10.01 Pipeline - Item
Valves - Item
Riser Sets - Item
Connections to Existing Pipelines - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

When the Owner raises or lowers the invert of a pipeline by up to 150 mm, it shall not constitute a Change in the Work and adjustment shall not be made to the payment. Where the invert of a pipeline is raised or lowered by more than 150 mm, this shall then constitute a Change in the Work for the full extent of the change from the original grade.

TABLE 1
Test Phase Make-Up Amount for Pressure Polyethylene Pipe

Pipe Diameter mm	Make-Up Water litre/km
100	31.0
150	74.5
200	124.2
250	161.4
300	285.6
350	335.2

Appendix 413-A, November 2019
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer may consider including soil boring data, a geotechnical report, a subsurface report, or a soils report in the Tender Documents.

The designer should include the following in the Contract Documents:

- Pipe size, material, and class. (413.05.01)
- Gate valve end configuration. (413.05.04.02)
- Type of risers. (413.05.05)
- Alignment and grade tolerances for the pipe installation. (413.07.10)
- Valve type, location, and support. (413.07.14.01)
- Air release and air/vacuum valve locations. (413.07.14.02)
- Locations of riser sets. (413.07.15)
- Type of thrust restraints. (413.07.16)

The pipe diameter should be adequate to develop a flow velocity of 0.8 to 2.5 m/s in the pumping system.

Corrosion protection system provisions should be specified, if appropriate.

Tracer wire or tracer tape should be specified, if appropriate

Under conditions of high ground water, external fluids may enter via air release and air/vacuum release valves; therefore, appropriate measures should be taken.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 1103.010	Concrete Thrust Blocks for Tees, Plugs, and Horizontal Bends
OPSD 1103.020	Concrete Thrust Blocks for Vertical Bends

CONSTRUCTION SPECIFICATION FOR PIPELINE INSTALLATION BY TUNNELLING

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415-A **Commentary**

415.01 SCOPE

This specification covers the general requirements for pipeline installation by tunnelling.

415.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be as specified in the Contract Documents.

415.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

415.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 517 Dewatering of Pipeline, Utility, and Associated Structure Excavation

Ontario Provincial Standard Specifications, Material

OPSS 1350 Concrete - Materials and Production
OPSS 1440 Steel Reinforcement for Concrete

415.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Certificate of Conformance means a document issued by the Quality Verification Engineer confirming that the specified components of the Work are in general conformance with the requirements of the Contract Documents.

Pipeline means to include sewers, culverts, watermains, and forcemains.

Quality Verification Engineer (QVE) means an Engineer retained by the Contractor for the duration of construction, qualified to provide the services specified in the Contract Documents.

Rock means natural beds or massive fragments, or the hard, stable, cemented part of the earth's crust, igneous, metamorphic, or of sedimentary origin, which may or may not be weathered and includes boulders having a volume of 0.5 m^3 or greater.

415.04 DESIGN AND SUBMISSION REQUIREMENTS

415.04.01 Design Requirements

The primary liner shall be designed to support all soil and hydrostatic pressures and to withstand any additional loads caused by grouting or jacking thrusts. The primary liner design and access shaft details shall bear the seal and signature of an Engineer.

415.04.02 Submission Requirements

When any of the following information is not specified in the Contract Documents, it shall be submitted to the Contract Administrator for review a minimum of 14 Days prior to commencing tunnelling operations:

a) Design criteria.

b) Materials.

c) Construction shaft and portal details.

d) Tunnelling method.

e) Face support and other temporary support details.

f) Primary liner and support design details.

g) Material mixture for filling voids and procedures.

h) Tunnel boring machine information, if applicable.

i) Type and strength of rock bolts, if applicable.

j) Lighting and ventilation details.

k) Settlement monitoring plan.

l) Excavation and dewatering plan.

m) Testing and monitoring plan.

415.05 MATERIALS

415.05.01 Concrete

Concrete shall be according to OPSS 1350 and with a nominal minimum 28-Day compressive strength of 30 MPa, unless otherwise specified in the Contract Documents

415.05.02 Steel Reinforcement

Steel reinforcement for concrete work shall be according to OPSS 1440.

415.05.03 Primary Liner

The primary liner shall be as specified in the Contract Documents or according to the Contractor's submission.

415.05.04 Rock Bolts

Rock bolts and nuts shall have a minimum tensile strength of 400 MPa.

415.06 EQUIPMENT

The Contractor shall select and use Equipment and associated methods compatible with the selected dimensions of the tunnel and with the subsurface and groundwater conditions at the site.

415.07 CONSTRUCTION

415.07.01 General

The location of tunnels shall be established from the plan, lines, elevations, and tolerances as specified in the Contract Documents.

All reference points necessary to construct the tunnel and appurtenances shall be laid out prior to commencement of the tunnelling operation.

The Contract Administrator shall be provided with the assistance and access necessary to check the layout of the tunnel and associated appurtenances.

415.07.02 Construction Shafts

Construction shafts shall be provided at locations as specified in the Contract Documents or according to the Contractor's submission.

Shafts shall be maintained in a drained condition.

A secure fence shall be installed around the perimeter of the construction shaft area with gates and truck entrances. The fence shall be removed upon completion of the work.

415.07.03 Stability of Excavation

The construction methods, plant, and procedures employed shall ensure that the excavations are stable, free from disturbance, and maintained in a drained condition.

The construction methods, plant, and materials employed shall prevent the migration of soil material into tunnels or shafts.

415.07.04 Tunnelling

An individual with previous experience in the construction of tunnels shall supervise the work at all times.

The tunnelling method shall be suitable to deal with changing ground conditions that may be encountered during the progress of the work.

Methods of excavating the tunnel shall be capable of fully supporting the face and shall accommodate the removal of boulders and other oversize objects from the face.

The tunnel shall be kept sufficiently dry at all times to permit work to be performed in a safe and satisfactory manner.

415.07.05 Dewatering

Dewatering shall be according to OPSS 517.

415.07.06 Primary Liner

The primary liner shall be installed so that the exterior is as tight as possible to the excavated surface of the tunnel and allows the placement of the full design thickness of the secondary lining.

All voids between the primary lining and the excavation shall be filled. If an unexpanded liner is used, the space outside the liner plates shall be grouted at least daily or more often as required.

Tunnels excavated in sound rock shall be supported in a manner that prevents scaling and unravelling of the rock and also protects the rock from weathering or deterioration.

Tunnels excavated in unstable rock shall be supported by means of rock bolts or another primary lining system in a manner that safely sustains the tunnel excavation.

415.07.06.01 Primary Liner Support Systems

Primary liner support systems shall minimize ground movement into the excavation, ensure stability, and maintain strength of the ground surrounding the excavation.

Primary liner support systems shall be compatible with encountered ground conditions, method of excavation, method of groundwater control, and with the placement of permanent liners.

Primary liner support systems shall prevent weathering, deterioration, loosening, or unravelling of ground surfaces exposed by excavation.

415.07.06.02 Single Liner Systems

Single liner systems shall be as specified in the Contract Documents.

415.07.07 Secondary Liner

The secondary liner shall be as specified in the Contract Documents.

The void between the primary and the finished secondary liners shall be filled as specified in the Contract Documents or according to the Contractor's submission.

415.07.08 Testing and Monitoring

Testing and monitoring shall be as specified in the Contract Documents or according to the Contractor’s submission.

415.07.09 Certificate of Conformance

A completed Certificate of Conformance shall be submitted to the Contract Administrator upon completion of the work. The Quality Verification Engineer shall affix his or her seal and signature to the completed Certificate of Conformance confirming that the following are in general conformance with the requirements of the Contract Documents:

a) Work

b) Material and installations

c) Inspection, testing, and test results

415.07.10 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

415.09 MEASUREMENT FOR PAYMENT

415.09.01 Actual Measurement

415.09.01.01 Tunnel

Measurement of tunnel shall be by length in metres along the centreline of the tunnel from centre to centre of maintenance holes or chambers or to the ends of the tunnel, where no maintenance hole or chamber is installed.

415.09.01.02 Rock Excavation in Tunnelling

Measurement of rock excavation in tunnelling shall be by volume in cubic metres based on the neat lines of the tunnel as shown in the Contract Documents.

415.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

415.10 BASIS OF PAYMENT

415.10.01 Tunnel - Item
Rock Excavation in Tunnelling - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Appendix 415-A, November 2018
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

This specification was written to encompass the requirements for the construction of pipelines and drainage conduits by the tunnelling method. It is not intended to be a specification for other tunnelling applications such as the transportation industry, mining, hydro electric, petroleum exploration industry, etc.

Engineering design based on geotechnical pre-design information is essential prior to the use of this specification for tunnelling projects.

The experience of the tunnelling Contractor is of prime importance. The designer may recommend prequalification of bidders.

The designer should specify the following in the Contract Documents:

- The strength of concrete required (415.05.01)

- Primary liner requirements. Alternatively, the designer may elect that the Contractor is responsible for determining the primary liner design details, in accordance with the Owner's specifications. (415.05.03)

- The plan, lines, elevations, and tolerances required for the tunnelling project. (415.07.01)

- Location of required construction shafts. Alternatively, the designer may elect to specify that the Contractor is responsible for determining shaft locations to suit the method of construction, subject to available access, and other Owner requirements. (415.07.02)

- The appropriate single liner systems type, class, dimensions, etc. (415.07.06.02)

- The appropriate secondary liner type, class, dimensions, etc. (415.07.07)

- The method of verifying the product installation. This may include reporting information from the tunnelling machine, daylighting, trace wire, survey, acoustic or magnetic location, GPS, closed-circuit television (CCTV) inspection, or mandrel tests. The designer should also specify the applicable leakage, infiltration, exfiltration, or pressure test requirements for the installation. This may apply to either the primary and secondary liner or just the secondary liner. (415.07.08)

The designer should consider providing benchmark and reference points for laying out the project.

The designer should consider specifying if the shafts are to remain in place or be removed upon completion of the project. If the shafts are to remain in place, further details should be provided as to how they should be covered or remain accessible for future use. The designer may determine if separate payment is appropriate for shafts.

The designer may wish to consider including a process regarding payment for failed tunnelling attempts in the Contract Documents.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

ONTARIO
PROVINCIAL
STANDARD
SPECIFICATION

OPSS.MUNI 416
NOVEMBER 2018
(Formerly OPSS 416, November 2013)

Note: The MUNI implemented in November 2018 replaces OPSS 416 COMMON, November 2013 with no technical content changes.

CONSTRUCTION SPECIFICATION FOR PIPELINE AND UTILITY INSTALLATION BY JACKING AND BORING

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416-A **Commentary**

416.01 SCOPE

This specification covers the requirements for the installation of pipeline, which shall be used as carrier pipe or casing pipe, by jacking and boring method, and includes removal of material by either manual or mechanical means.

416.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be as specified in the Contract Documents.

416.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

416.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 517 Dewatering of Pipeline, Utility, and Associated Structure Excavation

Ontario Provincial Standard Specifications, Material

OPSS 1802 Smooth Walled Steel Pipe
OPSS 1820 Circular and Elliptical Concrete Pipe

American Water Works Association (AWWA)

C206-03 Field Welding of Steel Water Pipe

416.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Carrier Pipe means a final pipe in direct contact with the material being conveyed.

Certificate of Conformance means a document issued by the Quality Verification Engineer confirming that the specified components of the Work are in general conformance with the requirements of the Contract Documents.

Pipeline means to include sewers, culverts, watermains, and forcemains.

Quality Verification Engineer (QVE) means an Engineer retained by the Contractor for the duration of construction, qualified to provide the services specified in the Contract Documents.

416.04 DESIGN AND SUBMISSION REQUIREMENTS

416.04.01 Submission Requirements

When any of the following information is not specified in the Contract Documents, it shall be submitted to the Contract Administrator for review a minimum of 14 Days prior to commencing jacking and boring operations:

a) Work area layout.

b) Work schedule.

c) Access shaft or pit design details.

d) Jacking and boring procedure.

e) Face support and other temporary support details.

f) Material and Equipment.

g) Settlement monitoring plan.

h) Excavation and dewatering plan.

i) Method for the removal of boulders and cobbles.

j) Grouting operation.

k) Testing and monitoring plan.

The access shaft or pit details shall bear the seal and signature of an Engineer.

416.05 MATERIALS

416.05.01 Casing Pipe

The casing pipe shall be concrete or steel pipe as specified in the Contract Documents.

Concrete pipe shall be according to OPSS 1820.

Steel pipe shall be according to OPSS 1802 with welded joints.

416.07 CONSTRUCTION

416.07.01 General

An individual with previous experience in jacking and boring shall supervise the work at all times.

416.07.02 Method of Jacking and Boring Procedure

The jacking and boring procedure to be used shall be submitted to the Contract Administrator prior to commencing the work and shall be subject to the following limitations:

a) Hydraulically operated jacks of adequate number and capacity shall be provided to ensure smooth and uniform advancement without over-stressing of the pipe.

b) A jacking head or collar shall be provided to transfer and distribute jacking pressure uniformly over the entire end bearing area of the pipe.

c) The casing pipe shall be fully supported in the jacking pit at the lines and grades as specified in the Contract Documents.

d) The jacking and boring procedure shall be compatible with the subsurface and groundwater conditions at the site.

416.07.03 Construction Shafts

Construction shafts shall be provided at the locations specified in the Contract Documents or according to the Contractor's submission.

Shafts shall be maintained in a drained condition.

A secure fence shall be installed around the perimeter of the access shaft or pit area with gates and truck entrances. The fence shall be removed upon completion of the work.

416.07.04 Dewatering

Dewatering shall be according to OPSS 517.

416.07.05 Pipeline Installation

The pipeline shall be installed to the lines, grades, and tolerances as specified in the Contract Documents.

When steel pipe is used as a carrier pipe, welding of pipe joints shall be according to AWWA C206.

When steel pipe is used solely as a casing pipe, the welds shall be sufficient to support the jacking forces of the pipeline installation.

The work area shall be kept sufficiently dry at all times to permit work to be performed in a safe and satisfactory manner.

The space between the casing pipe and the excavation shall be filled according to the Contractor's submission on grouting operations.

The space between the casing pipe and the carrier pipe shall be filled according to the Contractor's submission on grouting operations.

416.07.06 Removal of Boulders and Cobbles

Methods for the removal of boulders and cobbles shall be as detailed in the Contractor's submission. The Contract Administrator shall be informed immediately of any obstructions encountered.

416.07.07 Cathodic Protection

When specified in the Contract Documents, cathodic protection on the casing pipe shall be provided.

416.07.08 Testing and Monitoring

Testing and monitoring shall be as specified in the Contract Documents or in accordance to the Contractor's submission.

416.07.09 Certificate of Conformance

A completed Certificate of Conformance shall be submitted to the Contract Administrator upon completion of the work. The Qualification Verification Engineer shall affix his or her seal and signature to the completed Certificate of Conformance confirming that the following are in general conformance with the requirements of the Contract Documents:

a) Work

b) Material and installations

c) Inspection, testing, and test results

416.07.10 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

416.09 MEASUREMENT FOR PAYMENT

416.09.01 Actual Measurement

416.09.01.01 Jacking and Boring

Measurement of jacking and boring shall be by length in metres along the centreline of the casing pipe from the start to the end of the installed pipe.

416.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

416.10 BASIS OF PAYMENT

416.10.01 Jacking and Boring - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

The removal of boulders having a volume in excess of 0.5 cubic metres shall be paid for as Extra Work.

Appendix 416-A, November 2018
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

This specification was written to encompass the requirements for the construction of pipelines and or casings by the jacking and boring method. The primary application includes the construction of pipelines, and drainage conduits under highways, urban roads, and railway crossings.

Engineering design based on geotechnical pre-design information is essential to the use of this specification for jacking and boring projects.

The experience of the jacking and boring Contractor is of prime importance. The designer may recommend prequalification of bidders.

The designer should specify the following in the Contract Documents:

- The size and type of pipeline material to be used for the pipeline installation. This should include the required yield strength of steel pipe or the appropriate class or reinforcement of concrete pipe. (416.05.01)

- Lines and grades for casing pipe. (416.07.02)

- The construction shaft locations. This may include the access shaft to initiate the jacking and boring, and if required, the access shafts at both ends of the jacking. Also, the requirement for temporary shafts and whether they shall be removed or remain in place for other portions of the work. (416.07.03)

- The lines, grades, and tolerances required for the jacking and boring project. (416.07.05)

- The method of testing and monitoring the product installation. (416.07.08)

The designer should determine if the following is required and, if so, specify it in the Contract Documents:

- Cathodic protection of steel pipe or casing and the details thereof. (416.07.07)

The designer may wish to consider including a process for the grouting operation between the casing pipe and the carrier pipe, taking into account the high grout pressures that may occur.

The designer may wish to consider including a process regarding payment for failed jacking and boring attempts in the Contract Documents.

The designer may wish to specify a process and payment criteria to deal with rock obstructions that are encountered with jacking installation.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

CONSTRUCTION SPECIFICATION FOR PIPE CULVERT INSTALLATION IN OPEN CUT

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421-A **Commentary**

421.01 SCOPE

This specification covers the requirements for the installation of pipe culverts, pipe culvert end sections, and concrete appurtenances in open cut.

421.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

421.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

421.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standards Specifications, Construction

OPSS 206	Grading
OPSS 401	Trenching, Backfilling, and Compacting
OPSS 404	Support Systems
OPSS 409	Closed-Circuit Television (CCTV) Inspection of Pipelines
OPSS 490	Site Preparation for Pipelines, Utilities, and Associated Structures
OPSS 491	Preservation, Protection, and Reconstruction of Existing Facilities
OPSS 492	Site Restoration Following Installation of Pipelines, Utilities, and Associated Structures
OPSS 510	Removal
OPSS 517	Dewatering of Pipeline, Utility, and Associated Structure Excavation
OPSS 539	Temporary Protection Systems
OPSS 904	Concrete Structures
OPSS 905	Steel Reinforcement for Concrete

Ontario Provincial Standard Specifications, Material

OPSS 1004	Aggregates - Miscellaneous
OPSS 1205	Clay Seal
OPSS 1301	Cementing Materials
OPSS 1302	Water
OPSS 1350	Concrete - Materials and Production
OPSS 1440	Steel Reinforcement for Concrete
OPSS 1801	Corrugated Steel Pipe Products
OPSS 1820	Circular Concrete Pipe

OPSS 1840 Non-Pressure Polyethylene Plastic Pipe Products
OPSS 1841 Non-Pressure Polyvinyl Chloride (PVC) Pipe Products
OPSS 1843 Non-Pressure Polypropylene (PP) Plastic Pipe Products
OPSS 1860 Geotextiles

ASTM International

C 507-12 Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe

421.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Backfilling means the operation of filling the trench with bedding, cover, and backfill material or embedment and backfill material.

Concrete Appurtenances means concrete head walls, cut-off walls, stiffeners, aprons, collars, and any other concrete fixtures associated with the pipe culvert, excluding concrete bedding or concrete structures specified in the Contract Documents.

Culvert End Section means appurtenances attached to the ends of culverts for hydraulic, safety, or slope stability purposes.

Excavation means the excavation classified as earth and rock according to OPSS 206.

Flexible Pipe means pipe that can deflect 2% or more without cracking, such as polyvinyl chloride, polyethylene, or steel pipe.

Pipe Class means a pipe's physical material specification, such as load and pressure ratings, wall thickness, protective coatings, corrugation profiles, ring stiffness constants, and reinforcement.

Pipe Culvert means an installation designed to provide for the conveyance of surface water, pedestrians, or livestock using preformed or precast pipe sections, circular or non-circular in cross-section, laid end to end using suitable joint materials.

Pipe Type means a pipe's inner wall design, which can be smooth or corrugated.

Polypropylene Plastic means a material made with virgin polymers in which propylene is essentially the sole monomer.

421.05 MATERIALS

421.05.01 Pipe Materials

421.05.01.01 General

Pipe culvert size, type, and class shall be as specified in the Contract Documents.

Pipe culvert type shall be consistent throughout the length of the pipe culvert as specified in the Contract Documents.

Fittings shall be suitable for and compatible with the pipe type and class for which they will be used.

421.05.01.02 Concrete Pipe

Circular concrete pipe and joints shall be according to OPSS 1820.

Elliptical concrete pipe and joints shall be according to ASTM C 507.

421.05.01.03 Corrugated Steel Pipe Products

Corrugated steel pipe products shall be according to OPSS 1801.

421.05.01.04 Polyethylene Pipe Products

Polyethylene pipe products shall be according to OPSS 1840.

421.05.01.05 Polyvinyl Chloride Pipe Products

Polyvinyl chloride pipe products shall be according to OPSS 1841.

421.05.01.06 Polypropylene Plastic Pipe Products

Polypropylene plastic pipe products shall be according to OPSS 1843.

421.05.02 Mortar

Mortar for joints shall consist of one part Portland cement and two parts mortar sand, wetted with sufficient water to only make the mixture plastic. The mortar sand shall be according to OPSS 1004, the normal Portland cement shall be according to OPSS 1301, and the water shall be according to OPSS 1302.

421.05.03 Clay Seal

Clay seal material shall be according to OPSS 1205.

421.05.04 Concrete

Concrete for concrete appurtenances shall be according to OPSS 1350 with a nominal minimum 28-Day compressive strength of 30 MPa.

421.05.05 Steel Reinforcement

Steel reinforcement shall be of the size and grade specified in the Contract Documents and shall be according to OPSS 1440.

421.05.06 Geotextile

Geotextile shall be according to OPSS 1860.

421.07 CONSTRUCTION

421.07.01 Site Preparation

Site preparation shall be according to OPSS 490.

421.07.02 Removals

Removals shall be according to OPSS 510.

421.07.03 Preservation and Protection of Existing Facilities

Preservation and protection of existing facilities shall be according to OPSS 491.

421.07.04 Protection Against Floatation

Damage to the pipeline due to floatation shall be prevented during construction and until completion of the work.

421.07.05 Cold Weather Work

All work shall be protected from freezing. Pipes and bedding material shall not be placed on frozen ground.

421.07.06 Transporting, Unloading, Storing, and Handling Pipe

Manufacturer's recommendations for transporting, unloading, storing, and handling of pipe, shall be followed.

All pipes, fittings, and gaskets that are unsound or damaged shall be rejected.

421.07.07 Excavation

Excavation for the placement of pipe culverts shall be according to OPSS 401.

421.07.08 Support Systems

Support systems shall be according to OPSS 404.

421.07.09 Dewatering

Dewatering shall be according to OPSS 517.

421.07.10 Protection Systems

The construction of all protection systems shall be according to OPSS 539. When the stability, safety or function of an existing roadway, railway, other works, or proposed works may be impaired due to the method of operation, such protection as may be required shall be provided. Protection may include sheathing, shoring and driving piles, when necessary, to prevent damage to such works or proposed works.

421.07.11 Backfilling and Compacting

Backfilling and compacting shall be according to OPSS 401.

421.07.12 Pipe Installation

421.07.12.01 General

If a universal dimple coupler or any other coupler does not follow the contour of the flexible pipe sections to be joined, polyethylene gaskets shall then be installed at all joints when such couplers are used. Polyethylene gaskets shall be installed symmetrically about the pipe joint, between the coupler and the pipe, and shall be of sufficient length to equal the circumference of the pipe plus a minimum overlap of 300 mm.

Pipe shall be laid within the alignment and grade tolerances specified in the Contract Documents. When bell and spigot pipe is laid, the bell end of the pipe shall be laid upgrade.

Pipe shall be kept clean and dry as work progresses. The trench shall be kept dry. A removable watertight bulkhead shall be installed at the open end of the last pipe laid whenever work is suspended.

Pipe shall not be laid until the preceding pipe joint has been completed and the pipe is carefully embedded and secured in place.

When the Owner raises or lowers the invert of a pipe culvert by up to 150 mm, it shall not constitute a Change in the Work and no adjustment shall be made to the payment. When the invert of a pipe culvert is raised or lowered by more than 150 mm, then this shall constitute a Change in the Work for the full extent of the change from the original grade.

The pipe culvert cut-end finish, end sections, and safety slope end treatments shall be as specified in the Contract Documents.

When installing gaskets, all pipe ends shall be thoroughly cleaned. For gaskets requiring field lubrication, a lubricant recommended by the pipe manufacturer shall be used.

When gaskets have been affixed, the pipe shall be handled in a way so that the gasket is not damaged, displaced, or contaminated with foreign matter. Any gasket displaced or contaminated shall be removed, cleaned, and lubricated, if required, and reinstalled before closure of the joint is attempted. When specified in the Contract Documents, nitrile gaskets shall be used.

The pipe shall be properly positioned by means of an appropriate mechanism. Sufficient pressure shall be applied in making the joint to ensure that the joint is in position. Sufficient restraint shall be applied to the line to ensure that joints are held in this position.

Once the pipe has been jointed, a test shall be made with a feeler gauge at intervals around the joint to ensure that the gasket has not been displaced from the spigot groove. If the gasket is found out of position, the joint shall be opened and the gasket placed in its proper position. If necessary, a new gasket shall be installed.

421.07.12.02 Circular Concrete Pipe

All circular concrete pipe joints shall have elastomeric gaskets.

421.07.12.03 Non-Circular Concrete Pipe

All non-circular concrete pipe joints shall be according to the procedures recommended by the manufacturer.

421.07.12.04 Corrugated Steel Pipe Products

Helical corrugated steel pipe without rerolled ends shall be installed so that the helix angle is constant for the total length of the installation. Each pipe section shall be installed next to the previous section so that the lockseam forms a continuous helix. For rerolled ends, the correct fit of the coupling system does not depend on the location of the helical lockseam and corrugation.

Corrugated steel pipe sections shall be joined by means of steel couplers. The couplers shall be installed to lap approximately equal portions of the pipe being connected so that the corrugations or projections of the coupler properly engage the pipe corrugations. As the coupler is being tightened, it shall be tapped with a mallet to take up the slack.

When joint seals are specified in the Contract Documents, they shall be installed immediately prior to the installation of steel couplers.

Structural plate pipe culverts may be assembled in the trench or beside the excavation. If the assembled structure has to be moved to its final position, it shall be moved so that no damage or distortion is caused to the structure.

When the structural plate pipe culvert has been placed to the alignment and grade as specified in the Contract Documents, all assembly bolts shall be retightened with a torque wrench to a minimum of:

a) 200 N·m for 3.5 and 3.0 mm gauge of pipe.

b) 340 N·m for heavier than 3.5 mm gauge of pipe.

421.07.12.05 Polyethylene Pipe

Polyethylene pipe shall be jointed by one of the following methods, as recommended by the pipe manufacturer:

a) Bell and Spigot

b) Welded Joint

c) Thermal Fusion Joint

d) Screw-on Coupler

e) Split Coupler

f) Threaded Joint

421.07.12.06 Polyvinyl Chloride Pipe

Polyvinyl chloride pipe shall be jointed, as recommended by the manufacturer, using a bell and spigot joint with an elastomeric gasket.

At the end of a day's work, the last pipe shall be blocked as may be required to prevent movement.

421.07.12.07 Polypropylene Pipe

Polypropylene pipe shall be jointed by means of a bell and spigot joint with elastomeric gasket or a coupler joint as recommended by the manufacturer to satisfy the pipe joint specification.

421.07.13 Closed-Circuit Television (CCTV) Inspection

When specified in the Contract Documents, pipe culverts shall be inspected using CCTV equipment. CCTV inspection of pipe culverts shall be according to OPSS 409.

421.07.14 Cleaning and Flushing of Pipe Culverts

When specified in the Contract Documents, pipe culverts shall be cleaned and flushed just prior to inspection and acceptance.

421.07.15 Clay seal

Clay seal shall be placed as specified in the Contract Documents and compacted to 95% of the Proctor maximum dry density.

421.07.16 Concrete Appurtenances

Concrete appurtenances shall be constructed as specified in the Contract Documents. Concrete in concrete appurtenances shall be placed according to OPSS 904. Steel reinforcement shall be placed according to OPSS 905. Steel grating shall be installed when specified in the Contract Documents.

421.07.17 Site Restoration

Site restoration shall be according to OPSS 492.

421.07.18 Management of Excess Material

Management of excess material shall be as specified in the Contract Documents.

421.09 MEASUREMENT FOR PAYMENT

421.09.01 Actual Measurement

421.09.01.01 Pipe Culverts
Non-Circular Pipe Culverts
Pipe Culvert Extensions
Non-Circular Pipe Culvert Extensions

Measurement of pipe culverts, non-circular pipe culverts, pipe culvert extensions, and non-circular pipe culvert extensions shall be along the horizontal length of the pipe in metres, from one end of the pipe to the other end of the pipe. When the grade of the pipe culvert is 10% or greater, the above measurement shall then be of the slope length.

421.09.01.02 Concrete Appurtenances

Measurement for concrete appurtenances shall be by volume in cubic metres for the volume of concrete placed. Alternatively, concrete appurtenances may be a lump sum item.

421.09.01.03 Clay Seal

Measurement for clay seal shall be by volume in cubic metres for the volume of clay placed. Alternatively, clay seal may be a lump sum item.

421.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

421.10 BASIS OF PAYMENT

421.10.01 ***"size, type, class"*** **Pipe Culverts - Item**
"size, type, class" **Non-Circular Pipe Culverts - Item**
"size, type, class" **Pipe Culvert Extensions - Item**
"size, type, class" **Non-Circular Pipe Culvert Extensions - Item**
Clay Seal - Item
Concrete Appurtenances – Item
Culvert End Section – Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

421.10.02 Swamp Excavation

When the Contract requires swamp excavation to place a pipe culvert, payment for the swamp excavation shall be under the tender item covering the swamp excavation for earth embankment construction. No alterations shall be made to the tender item for the pipe culvert so affected.

421.10.03 Closed-Circuit Television (CCTV) Inspection

When a CCTV inspection of pipe culverts is specified in the Contract Documents, payment for the CCTV inspection shall be according to OPSS 409.

Appendix 421-A, November 2018
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Pipe culvert size, type, and class. (421.05.01.01)
- Size and grade of steel reinforcement. (421.05.05)
- Alignment and grade tolerances, including camber, for the pipe installation. (421.07.12.01)
- Pipe culvert cut-end finish, end sections, and safety slope end treatments. (421.07.12.01)
- Alignment and grade for the placement of structural plate pipe culvert. (421.07.12.04)
- Placement of clay seal at the inlet side of culverts, as required. (421.07.15)
- Requirements to construct concrete appurtenances. (421.07.16)
- Pipe culvert size, type, class, shape, clay seal, concrete appurtenances, and end sections to complete the tender item description. (421.10.01)

The designer should determine if the following are required and, if so, add the requirement in the Contract Documents:

- Use of nitrile gaskets. (421.07.12.01)
- Use of joint seals with corrugated steel pipe products. (421.07.12.04)
- CCTV inspection and any other testing. (421.07.13)
- Cleaning and flushing prior to inspection and acceptance. (421.07.14)
- Use of steel grating. (421.07.16)
- Payment of concrete appurtenances by volume or lump sum. (421.09.01.02)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 800.010	Concrete Pipe Culvert and Sewer Extensions Using Corrugated Steel Pipe
OPSD 800.011	Concrete Rigid Frame Box and Open Culvert Extensions Using Corrugated Steel Pipe
OPSD 801.010	Cut End Finish, Circular Pipe and Pipe-Arch Corrugated Steel Pipe
OPSD 801.020	End Section Details, Corrugated Steel Pipe
OPSD 801.030	Bevel Details for Structural Plate Pipe and Pipe-Arch - Corrugated Steel Pipe

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OPSD 801.040	Culvert and Sewer Safety Slope End Treatment, Notes and Tables
OPSD 801.041	Culvert and Sewer Safety Slope End Treatment, Assembly Details
OPSD 801.042	Culvert and Sewer Safety Slope End Treatment, Connection Details
OPSD 801.043	Culvert and Sewer Safety Slope End Treatment, Installation Details
OPSD 802.010	Flexible Pipe Embedment and Backfill, Earth Excavation
OPSD 802.013	Flexible Pipe Embedment and Backfill, Rock Excavation
OPSD 802.014	Flexible Pipe Embedment in Embankment, Original Ground: Earth or Rock
OPSD 802.020	Flexible Pipe Arch Embedment and Backfill, Earth Excavation
OPSD 802.023	Flexible Pipe Arch Embedment and Backfill, Rock Excavation
OPSD 802.024	Flexible Pipe Arch Embedment in Embankment, Original Ground: Earth or Rock
OPSD 802.030	Rigid Pipe Bedding, Cover, and Backfill, Type 1 or 2 Soil - Earth Excavation
OPSD 802.031	Rigid Pipe Bedding, Cover, and Backfill, Type 3 Soil - Earth Excavation
OPSD 802.032	Rigid Pipe Bedding, Cover, and Backfill, Type 4 Soil - Earth Excavation
OPSD 802.033	Rigid Pipe Bedding, Cover, and Backfill, Rock Excavation
OPSD 802.034	Rigid Pipe Bedding and Cover in Embankment, Original Ground: Earth or Rock
OPSD 802.050	Horizontal Elliptical Rigid Pipe Bedding, Cover, and Backfill, Type 1 or 2 Soil - Earth Excavation
OPSD 802.051	Horizontal Elliptical Rigid Pipe Bedding, Cover, and Backfill, Type 3 Soil - Earth Excavation
OPSD 802.052	Horizontal Elliptical Rigid Pipe Bedding, Cover, and Backfill, Type 4 Soil - Earth Excavation
OPSD 802.053	Horizontal Elliptical Rigid Pipe Bedding, Cover, and Backfill, Rock Excavation
OPSD 802.054	Horizontal Elliptical Rigid Pipe Bedding and Cover in Embankment, Original Ground: Earth or Rock
OPSD 802.095	Clay Seal for Pipe Trenches
OPSD 804.030	Concrete Headwall, for Pipe Less Than 900 mm Diameter
OPSD 804.040	Concrete Headwall, for Sewer or Culvert Pipe Outlet
OPSD 804.050	Grating, for Concrete Endwall
OPSD 805.010	Height of Fill Table, Round Corrugated Steel Pipe and Structural Plate Corrugated Steel Pipe
OPSD 805.020	Height of Fill Table, Corrugated Steel Pipe Arch and Structural Plate Corrugated Steel Pipe Arch
OPSD 805.030	Height of Fill Table, Spiral Rib Round Pipe
OPSD 805.040	Height of Fill Table, Spiral Rib Pipe Arch
OPSD 806.020	Height of Fill Table, Dual Wall Corrugated Polyethylene Gravity Sewer Pipe, 210 and 320 kPa
OPSD 806.021	Height of Fill Table, Closed Profile Wall Polyethylene Pipe, RSC 160 and 250
OPSD 806.022	Height of Fill Table, Dual Wall Corrugated Polyethylene Gravity Sewer Pipe RSC 100 and RSC 160
OPSD 806.030	Height of Fill Table, Dual and Triple Wall Corrugated Polypropylene Gravity Sewer Pipe, 320 kPa
OPSD 806.040	Height of Fill Table, Polyvinyl Chloride Gravity Sewer Pipe, 210, 320, and 625 kPa
OPSD 806.060	Height of Fill Table, Polyvinyl Chloride Pressure Pipe for Different Dimension Ratios
OPSD 807.010	Height of Fill Table, Reinforced Concrete Pipe - Confined Trench, Class 50-D, 65-D, 100-D, and 140-D
OPSD 807.030	Height of Fill Table, Reinforced Concrete Pipe - Embankment, Class 50-D, 65-D, 100-D, and 140-D
OPSD 807.040	Height of Fill Table, Non-reinforced Concrete Pipe Class 3
OPSD 807.050	Height of Fill Table, Horizontal Elliptical Concrete Pipe, Class HE-A, HE-I, HE-II, HE-III, and HE-IV

CONSTRUCTION SPECIFICATION FOR PRECAST REINFORCED CONCRETE BOX CULVERTS IN OPEN CUT

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422-A **Commentary**

422.01 SCOPE

This specification covers the requirements for the installation of precast reinforced concrete box culverts and box in open cut, and includes the requirements for excavation, bedding, backfilling, and cover material.

422.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

422.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

422.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 209	Embankments Over Swamps
OPSS 404	Support Systems
OPSS 501	Compacting
OPSS 517	Dewatering
OPSS 539	Temporary Protection Systems
OPSS 902	Excavating and Backfilling - Structures
OPSS 904	Concrete Structures
OPSS 905	Steel Reinforcement for Concrete

Ontario Provincial Standard Specifications, Material

OPSS 1002	Aggregates - Concrete
OPSS 1004	Aggregates - Miscellaneous
OPSS 1010	Aggregates - Base, Subbase, Select Subgrade, and Backfill Material
OPSS 1205	Clay Seal
OPSS 1301	Cementing Materials
OPSS 1302	Water
OPSS 1350	Concrete - Materials and Production
OPSS 1440	Steel Reinforcement for Concrete
OPSS 1821	Precast Reinforced Concrete Box Culverts
OPSS 1860	Geotextiles

MTO Laboratory Testing Manual

LS-706 Moisture - Density Relationship of Soils Using 2.5 kg Rammer and a 305 mm Drop

ASTM International

D2487-17e1 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
D2488-17e1 Standard Practice for Description and Identification of Soils (Visual-Manual Procedures)
D6938-17a Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

422.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Backfill means earth, rock, or granular material used as fill within the excavation placed beyond the limits of bedding and cover below the subgrade elevation, including frost tapers.

Bedding means the material used to support the bottom of the box unit.

Box Culvert means a culvert constructed of precast reinforced concrete box units rectangular in cross-section.

Box Unit means a single precast reinforced concrete box unit of a box culvert.

Concrete Appurtenances means head walls, cut-off walls, aprons, collars, and any other concrete fixtures associated with the box culverts , excluding concrete bedding or concrete structures covered elsewhere in the Contract Documents and specified as such.

Cover means the material placed as a protective layer around the box unit to prevent damage to the box unit.

Distribution Slab means a reinforced concrete slab placed directly on the top slab of a box culvert to distribute loading.

Excavation, Earth and Rock means the excavation material classified as earth and rock according to OPSS 902.

Excavation, Swamp means swamp excavation as defined in OPSS 209.

Geotechnical Engineer means a professional engineer licensed by the Professional Engineers of Ontario to practice in the Province of Ontario who is responsible for the work related to earth and rock, including site investigation, foundation recommendations, inspection, and quality control with respect to the design and installation of box culverts.

Native Material means the original material removed to form an excavation and which is acceptable to the Contract Administrator for return to the same or other excavation as backfill or cover.

Soil means soil as defined in OPSS 902.

422.04 DESIGN AND SUBMISSION REQUIREMENTS

Six copies of the fabrication and assembly drawings, including handling details, shall be submitted to the Contract Administrator two weeks prior to delivery of the box units.

422.05 MATERIALS

422.05.01 Concrete

Concrete for appurtenances and distribution slab shall be according to OPSS 1350.

422.05.02 Granulars

Granulars shall be according to OPSS 1010.

422.05.03 Fine Aggregates for Levelling Course

Fine aggregate for levelling courses shall be according to OPSS 1002.

422.05.04 Precast Reinforced Concrete Box Units

Precast reinforced concrete box units for spans not greater than 3 metres shall be according to OPSS 1821. Box unit reinforcement shall be consistent throughout a culvert as specified in the Contract Documents.

422.05.05 Clay Seal

Clay seal shall be according to OPSS 1205.

422.05.06 Steel Reinforcement

Steel reinforcement for concrete appurtenances and concrete distribution slab shall be according to OPSS 1440.

422.05.07 Mortar

Mortar for joints shall be composed of one part Portland cement type GU and two parts mortar sand wetted with only sufficient water to make the mixture plastic. The Portland cement type GU shall be according to OPSS 1301, mortar sand shall be according to OPSS 1004, and water shall be according to OPSS 1302.

422.05.08 Preformed Gasket

Preformed gaskets shall be as specified by the manufacturer of the box units.

422.05.09 Joint Sealing Compound

Joint sealing compound shall be butyl mastic as specified by the manufacturer of the box units.

422.05.10 Grout

Grout shall be non-shrink and non-staining.

422.05.11 Geotextile

Geotextile type shall be as specified in the Contract Documents and according to OPSS 1860.

422.05.12 Native Material

Native material shall be classified according to the Unified Soil Classification System using the procedures prescribed in ASTM D2488. When precise classification of native material is required, ASTM D2487 shall be used.

422.05.13 Bedding

Bedding shall be as specified in the Contract Documents. Earth bedding shall be classified as Group I or Group II according to Table 1.

The maximum particle size for bedding shall not exceed 25 mm in diameter, unless the bedding layer has a thickness of 150 mm or greater, in which case the maximum particle size shall not exceed 38 mm in diameter.

422.05.14 Backfill

Backfill shall be as specified in the Contract Documents. Earth backfill shall be classified as Group I, Group II, or Group III according to Table 1.

Earth backfill shall be free of boulders over 100 mm in diameter, topsoil, frozen materials, organic matter, and other deleterious material.

422.05.15 Cover

Cover shall be as specified in the Contract Documents. Earth cover shall be classified as Group I or Group II according to Table 1.

Cover shall be free of boulders having a diameter greater than 100 mm, debris, organic matter, or frozen materials.

422.07 CONSTRUCTION

422.07.01 Selection of Box Units

The box units shall be selected from Table 1 in OPSS 1821 based on the dimensions and height of fill specified in the Contract Documents.

422.07.02 Excavation

The excavation for the installation of the box units shall be according to OPSS 902, including frost tapers and culvert end treatments.

422.07.03 Support Systems

Support systems shall be according to OPSS 404.

422.07.04 Dewatering

Dewatering shall be according to OPSS 517.

422.07.05 Temporary Protection Systems

Temporary protection systems shall be according to OPSS 539.

422.07.06 Foundations

The foundation shall be comprised of firm to hard in situ soil or compacted backfill.

When unsuitable or unstable material is encountered during the excavation for the foundation, the unsuitable or unstable material shall be removed to firm to hard in situ soil and replaced to the foundation grade with compacted backfill meeting the requirements of Group I or Group II, according to Table 1. The foundation on each side of the box unit, for a minimum distance equal to the inside width of the box unit shall be at least as stable as the foundation below the box unit.

422.07.07 Bedding

Bedding shall be placed to the dimensions shown in the Contract Documents.

The bedding shall be placed as uniformly as possible. Bedding under the middle third of the box unit base shall be loosely placed and uncompacted. Bedding requiring compaction shall be placed in layers not exceeding 200 mm in thickness, loose measurement, and each layer shall be compacted according to OPSS 501.

Bedding shall not be placed on frozen earth grade.

422.07.08 Levelling

The surface prepared to support the box units shall have a 75 mm minimum thickness top levelling course of uncompacted Granular A or fine aggregates.

422.07.09 Installing Box Units

422.07.09.01 Box Units

Box units shall be installed to the alignment and grade specified in the Contract Documents.

Box units shall not be installed on bedding containing frozen material.

End units to accommodate concrete appurtenances shall be as specified in the Contract Documents.

The box units shall be installed to make a continuous line forming a box culvert. The gap at box unit joints shall not exceed 20 mm.

For box units placed in parallel for multiple cell installations, a 60 mm $\pm$ 10 mm gap filled with grout between adjacent cells shall be provided.

Installation of the box units shall commence at the outlet end and proceed in the upstream direction with the bell ends of the box units facing upgrade. The box units shall be placed with the base of each box unit in uniform contact with the prepared bedding throughout its full length. The ends of the box units shall be joined so there is no unevenness along the inside. The box units and joint surfaces shall be kept clean as work progresses. Water shall not be allowed to flow through the box units during installation. The excavation shall be kept dry and the box units shall not be installed in water.

422.07.09.02 Geotextile at Joints

A 600 mm wide strip of geotextile shall be placed to form a continuous barrier centered around the exterior of all buried joints not covered by a distribution slab.

Geotextile shall be free of folds, tears, and wrinkles. The geotextile shall be joined so that the material laps a minimum of 500 mm and shall be pinned together. Alternatively, the geotextile shall be joined according to the seam requirements of OPSS 1860.

Geotextile shall not be placed between the top slab of box units and distribution slabs. Where a distribution slab is required, the geotextile shall be held in place by cover and geotextile ends shall be secured to the box units.

422.07.09.03 Mortared Joints

When mortared joints are specified in the Contract Documents, all joints shall be thoroughly cleaned and wetted. Mortar shall then be applied over the joint around the inner and outer perimeter. After the mortar joint is complete the joint inside shall be wiped clean and smooth.

422.07.09.04 Preformed Gasket

When a preformed gasket is specified in the Contract Documents for sealing the joint between the box units, it shall be placed according to the manufacturer's recommendations.

422.07.09.05 Joint Sealing Compound

When joint sealing compound is specified in the Contract Documents for sealing the joint between the box units, it shall be applied according to the manufacturer's recommendations.

422.07.09.06 Lift Holes

All lift holes shall be filled with mortar after installation of the box unit.

422.07.10 Concrete Appurtenances and Concrete Distribution Slab

Concrete placement, sampling, and testing shall be according to OPSS 904. Reinforcing steel shall be placed according to OPSS 905. Steel grating shall be provided as specified in the Contract Documents.

422.07.11 Backfill

Backfill shall be placed in layers not exceeding 200 mm in thickness, loose measurement. Compaction shall be according to OPSS 501.

Backfilling on each side of the box units shall be completed simultaneously. At no time shall the levels on each side differ by more than 400 mm.

When native material is specified as backfill in the Contract Documents, earth material may be substituted, when approved by the Contract Administrator. In areas within the roadway, for a depth equal to the frost treatment, earth backfill shall have frost susceptibility characteristics similar to the native material. The Contract Administrator shall decide on the suitability of the earth backfill that the Contractor proposes to substitute.

Rock may be used as backfill provided the installed box units are protected by a minimum thickness of cover material as specified in the Contract Documents.

Box unit installation and backfill shall be completed prior to the start of any subbase and base course construction over the box unit location.

Shoring and bracing shall be withdrawn and removed as the excavation is being backfilled.

422.07.12 Cover

Cover shall be placed in layers not exceeding 200 mm in thickness, loose measurement, and each layer shall be compacted according to OPSS 501.

Cover in trenches and in other locations where pavements require controlled differential settlement shall be of a type and compaction level to control pavement differential settlement within acceptable limits for the specified type of pavement.

422.07.13 Clay Seal

When a clay seal is specified in the Contract Documents, the clay seal shall be placed to the dimensions specified in the Contract Documents and compacted to a minimum of 95% of the maximum dry density (MDD). The MDD shall be determined from LS-706, carried out on a single representative sample. Field density and field moisture determinations shall be made according to ASTM D6938.

422.07.14 Geotechnical Testing

When specified in the Contract Documents, compliance of earth backfill material type and compaction with the requirements of this specification shall be verified by a Geotechnical Engineer approved by the Contract Administrator.

422.07.15 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

422.09 MEASUREMENT FOR PAYMENT

422.09.01 Actual Measurement

422.09.01.01 Precast Reinforced Concrete Box Culverts

Measurement of the actual length of box culvert installed shall be made in metres along the centreline of the invert of the box culvert.

422.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clause under Actual Measurement.

422.10 BASIS OF PAYMENT

422.10.01 *"size"* Precast Concrete Box Culvert - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

422.10.02 Clay Seal - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

422.10.03 Granular

Granular material used for bedding and levelling courses, backfill, cover, and frost tapers shall be paid for under the appropriate granular items specified in the Contract Documents.

Payment will not be made for granular used to fill any area excavated beyond the lines specified in the Contract Documents or used as cover when acceptable earth cover is available.

422.10.04 Steel Reinforcement in Concrete Appurtenances

Payment for steel reinforcement in concrete appurtenances shall be according to OPSS 905.

422.10.05 Concrete in Appurtenances

Payment for concrete appurtenances shall be according to OPSS 904.

422.10.06 Excavation for Box Culverts

Payment for earth and rock excavation shall be according to OPSS 902.

422.10.07 Swamp Excavation

Where swamp excavation is required to place precast concrete box culverts, payment for the swamp excavation shall be under the tender item covering the swamp excavation for earth embankment construction.

TABLE 1
Group Classification for Earth Bedding, Backfill and Cover Materials

Group	Grain Size	Description	Symbols
I	Coarse	Well-Graded Gravel, Gravel-Sand Mixtures, little or no fines	GW
		Poorly-Graded Gravel, Gravel-Sand Mixtures, little or no fines	GP
		Well-Graded Sand, Gravelly Sand, little or no fines	SW
		Poorly-Graded Sand, Gravelly Sand, little or no fines	SP
II	Medium	Clayey Gravel or Gravel-Sand-Clay Mixtures	GC
		Clayey Sand or Sand-Clay Mixtures	SC
		Silty Sand or Sand-Silt Mixtures	SM
		Silty Gravels or Gravel-Sand-Silt Mixtures	GM
		Inorganic Silts and Very Fine Sands, Silty or Clayey Fine Sands, Clayey Silts	ML
III	Fine	Clayey Gravel or Gravel-Sand-Clay Mixtures	GC
		Clayey Sand or Sand-Clay Mixtures	SC
		Inorganic Clay, Gravelly Clay, Sandy Clay, Silty Clay, Lean Clay	CL
		Inorganic Silts, Micaceous or Diatomaceous Fine Sandy or Silty Soil	MH

Appendix 422-A, November 2021
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The design should specify the following in the Contract Documents:

- Geotextile type. (422.05.11)
- Bedding. (422.05.13)
- Backfill. (422.05.14)
- Cover. (422.05.15)
- Dimensions of box units and height of fill. (422.07.01)
- Bedding dimensions. (422.07.07)
- Alignment and grade of the box units. (422.07.09.01)
- Minimum cover material requirements for installation protection against rock backfill. (422.07.11)
- Clay seal. (422.07.13)

The designer should determine if the following is required and if so, specify in the Contract Documents:

- Concrete appurtenances. (422.07.09.01)
- Mortared joints. (422.07.09.03)
- Preformed gasket. (422.07.09.04)
- Joint sealing compound. (422.07.09.05)
- Steel grating. (422.07.10)
- Native backfill. (422.07.11)
- Geotechnical testing. (422.07.14)

To be complete, the tender item descriptions for Precast Concrete Box Culvert should include the size of the box unit.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 803.010	Backfill and Cover for Concrete Culverts
OPSD 3920.100	Precast Reinforced Concrete Box Culvert With Height Of Fill ≥ 0.6m
OPSD 3920.110	Precast Reinforced Concrete Box Culvert With Height Of Fill < 0.6m
OPSD 4040.05	Culverts Warning Message Layout Details
OPSD 4040.06	Culverts Warning Message Lettering Details

CONSTRUCTION SPECIFICATION FOR ZOOM CAMERA INSPECTIONS

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432-A Commentary

432.01 SCOPE

This specification covers the requirements for the use of zoom camera to inspect existing sanitary sewers, storm sewers, maintenance holes, pipe culverts or other accessible conduits.

432.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

432.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

432.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

CSA Standards

Pipeline Assessment and Certification Program (PACP®) Canadian Edition including CSA PLUS 4012 TECHNICAL GUIDE Visual inspection of sewer pipe

National Association of Sewer Service Companies

PACP Inspection Guidelines (October 2014)
MACP Inspection Guidelines

432.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

CCTV means Closed Circuit Television.

MACP means Manhole Assessment Certification Program.

NASSCO means National Association of Sewer Service Companies.

PACP means Pipeline Assessment Certification Program.

432.04 DESIGN AND SUBMISSION REQUIREMENTS

432.04.01 Submission Requirements

The following information shall be submitted to the Contract Administrator two weeks prior to the start of zoom camera inspection operations:

a) A sample inspection report and digital data file. One submission is required for each camera proposed for use on the work.

b) The details of the coding accuracy verification system that is to be used to verify inspection accuracy as outlined in the Quality Assurance section of this specification.

Digital file storage shall be as specified and shall have permanent labels that are capable of displaying the following information:

a) Owner's Name.

b) Contract Number or Project Name.

c) Sewer or Culvert Identification Number.

d) Maintenance hole Identification Number.

d) Region or Municipality.

e) Road name and location.

f) Inspection Date.

Photographs are to be in digital format and in colour.

432.06 EQUIPMENT

432.06.01 General

Handheld and portable zoom camera units shall not be substituted for truck-mounted zoom camera systems.

432.06.02 Survey Equipment

432.06.02.01 Survey Vehicle

The survey vehicle shall be a vehicle of appropriate size and weight to allow for inspection of maintenance holes located on municipal streets within close proximity. The survey vehicle shall contain a separate area for viewing, recording, and controlling the zoom camera operation, equipment, computer, video recording equipment and ancillary supplies.

432.06.02.02 Zoom Camera

The inspection and evaluation of the sewer system shall be performed using a waterproof, pan and tilt colour camera, capable of entering into a minimum maintenance hole cover size of 300 mm. The camera shall be equipped with a compatible remote controlled integrated lighting system capable of clearly illuminating the interior of a maintenance hole.

The zoom camera shall be equipped with a remote-controlled lighting system capable of providing a clear image of the interior of the sewer pipe for a minimum distance of:

a) 15 m for small diameter pipes less than 250 mm

b) 30 m for larger diameter sewers

The camera shall be detachable from the mobile unit for inspection of difficult or off road locations using a tripod. The equipment shall be capable of lowering the camera to a minimum depth of 7 m inside a maintenance hole.

432.06.03 Camera Illumination, Focus, and Features

The illumination shall be controlled from inside the mobile unit and adjustable light sources shall be compatible with the lens angle and dispersed in a manner such that any observations identified are clearly visible.

432.06.04 Digital Video Quality

Digital video quality shall be as per the following requirements:

a) Non-proprietary video formats such as MPEG2, MP4, WMV, AVI, or equivalent.

b) Picture Size: Minimum NTSC 640x480 @ 29.97 frames per second and 720P for high definition.

432.07 CONSTRUCTION

Zoom camera inspections shall be performed in accordance with the pipe condition coding practices as outlined in the PACP and MACP.

432.07.01 General

The work shall include a zoom camera inspection of the maintenance hole, pipe, sewer or culvert and the preparation of all video, digital, and written reports.

A certified operator shall be used to operate the inspection equipment and code the inspection.

At the start of each pipe sewer or culvert length, a data generator shall electronically generate and clearly display on the viewing monitor and video recording a record of data in alphanumeric form containing the following minimum information, or as specified by the Owner:

a) Pipe sewer or culvert dimensions.

b) Pipe material.

c) Maintenance hole and pipe length reference numbers.

d) Date of survey.

e) Road name and location.

f) Direction of survey.

g) Time of start of survey.

h) Pipe sewer or culvert use.

i) Weather.

Defects in each pipe sewer segment or maintenance hole shall be recorded according to the PACP or MACP. Any variation from the manual shall be noted in the survey report.

Inspections shall be recorded in colour.

432.07.02 Inspection Reporting – Final Documentation

Inspection reports shall be submitted to the Contract Administrator according to the following general guidelines:

a) Monthly Progress Reports documenting completed inspections.

b) Bi-Weekly Emergency Reports documenting sewer operating conditions requiring immediate attention.

c) Final Project Report summarizing network conditions and recommendations including but not limited to (one paper and one digital copy):
- Sewer lines requiring further CCTV inspections
- Sewer lines and maintenance holes requiring cleaning (hydraulic and special)
- Mapping corrections
- Updated sewer network plans
- Abandoned inspections

d) Sufficiently sized media storage device containing:
- Final project report
- Video inspection files
- Observation photo files
- PACP/MACP database
- Revised mapping files if applicable

Non-compliant submissions returned for correction shall be corrected and resubmitted at no expense to the Owner.

432.08 QUALITY ASSURANCE

Upon submission, printed and digital inspection reports, digital video recordings, PACP and/or MACP exchange database files, and coding accuracy checks shall be reviewed to ensure compliance with the requirements outlined.

Regular submittals shall be reviewed by the Contract Administrator to confirm the video quality and coding accuracy and their acceptance confirmed within 20 Business Days of submission. Only inspections with minimum accuracy for header information of 95% will be accepted. Non-compliant submissions will be returned for correction. Corrected submissions shall be returned to the Contract Administrator for review within 5 Business Days.

Operators failing to meet the coding accuracy requirements on two occasions shall not be permitted to code on the remainder of the Contract unless they successfully demonstrate the required level of qualification.

432.09 MEASUREMENT FOR PAYMENT

432.09.01 Actual Measurement

Measurement for a zoom camera inspection shall be measured per each maintenance hole to a sanitary or storm sewer and inlet or outlet end of culvert inspection. This shall include accessing the maintenance hole, maintenance hole inspection and viewing of all inlet and outlet pipes of the sewer or culvert.

432.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clause under Actual Measurement.

432.10 BASIS OF PAYMENT

432.10.01 Zoom Camera Inspection – Item

Payment at the Contract price per each shall be full compensation for all Labour, Equipment and Material to complete the inspection and related reporting, video and digital data file.

Appendix 432-A, November 2019
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.

CONSTRUCTION SPECIFICATION FOR LASER AND LiDAR SURVEYING OF PIPELINES

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434-A Commentary

434.01 SCOPE

This specification covers the requirements for inspecting new and existing storm and sanitary sewers, watermains, pipe culverts, or other accessible conduits by Laser or LiDAR surveying.

434.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be as specified in the Contract Documents.

434.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

434.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 409	Construction Specification for Closed Circuit Television (CCTV) Inspection of Pipelines
OPSS 411	General Specification for Cleaning and Flushing

American Society of Testing and Materials

ASTM F3095 - 14	Standard Practice for Laser Technologies for Direct Measurement of Cross-Sectional Shape of Pipeline and Conduit by Rotating Laser Diodes and CCTV Camera System
ASTM E2544 - 11a	Standard Terminology for Three-Dimensional (3D) Imaging Systems

NASSCO

PACP	Pipeline Assessment Certification Program

434.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Laser means Light Amplification by Stimulated Emission of Radiation.

Laser Profiling means using a visible laser in conjunction with a conventional CCTV camera.

LiDAR means Light Detection and Ranging.

LiDAR Scanning means the method of bouncing photons of light off of an object (in this case, the pipe wall) and measuring how long it takes for that light to return to the LiDAR scanner equipment.

Point Clouds means large data sets composed of 3D point data.

Registered Point Cloud means a 3D model created by utilizing relative positions and orientations of separately acquired point clouds and overlapping the intersecting areas to create an extended 3D model.

434.04 DESIGN AND SUBMISSION REQUIREMENTS

434.04.01 Submission Requirements

The following information shall be submitted to the Contract Administrator two weeks prior to the start of the Laser and LiDAR surveying operations:

a) The name of the inspection firm responsible for conducting the laser/LiDAR surveys.

b) A separate sample survey report as per NASSCO PACP requirements.

c) The details of the verification system used to determine the accuracy, calibration, and tolerance of the survey.

d) The make, model and serial number of the camera and laser/LiDAR.

Inspection reports submitted shall have at least the following information in the title or as specified in the Contract Documents:

a) Owner's Name.

b) Contract Number or Project Name.

c) Sewer or Culvert or Watermain Identification Numbers.

d) Region or Municipality.

e) Road Name and Location.

f) Inspection date.

Digital photograph files shall have a resolution of at least 640 x 480 pixels. The laser/LiDAR final report shall be submitted in hard colour copy and digital format on an external hard drive.

Submittals shall be reviewed by the Contract Administrator and their acceptance confirmed within 10 Business Days of submission. Non-compliant submissions shall be returned for correction. Corrected submissions shall be returned to the Contract Administrator for review within 10 Business Days.

434.06 EQUIPMENT

434.06.01 General

Imaging systems shall conform to ASTM E2544 - 11a.

While laser profiling and LiDAR Scanning collect similar information, they work using different methods. Both laser technologies are similar in that they only take measurements above the fluid level and do not work underwater.

Laser profiling projects a red ring onto the pipe wall at a precise distance in front of the CCTV camera. Image processing techniques then measure the size and shape of the red ring. Each frame of the video constitutes another cross-section measurement of the pipeline, and as the inspection progresses through the pipe, these cross-section slices can be analyzed to highlight areas where the pipe is corroding or deforming and presented in series to simulate a 3D model.

LiDAR Scanning measures how long it takes for light to return to the LiDAR scanner. This measured time-of-flight is then converted to a distance measurement. Photons of light can be sent out by the scanner at all angles in all directions. These individual measurements can be assembled into a full 3D model of the pipe interior, called a “point cloud.” The 3D model can then be analyzed to highlight areas where the pipe is corroding or deforming and additionally be analyzed to determine the longitudinal or central axis of the pipe.

Laser profiling can be used for analysis of cross section of the pipe from 150mm to 3000 mm diameter. LiDAR can be used for pipes where an analysis of the cross section of the pipe is required and/or determining the shape of the longitudinal or central axis of the pipe is required in pipes 900mm to 6600mm diameter.

Laser and LiDAR equipment used to inspect watermains shall have been used exclusively for work in watermains only.

Prior to commencement of the laser survey operations, a formal laser profile accuracy verification system shall be submitted to the Contract Administrator, and implemented when approved.

434.06.02 Laser Equipment

The laser profiler shall be a type which permits the measuring of actual deformities with a precision of at least 0.5%. The measurement of the actual pipe deflection shall be calculated with the actual interior diameter on all points of the pipe (not the nominal diameter).

The laser profiler shall be able to give a series of at least 180 diametrical measurements at any given measuring point within a pipe.

Laser profilers and associated appurtenances shall be capable of assessing a length of pipe sewer or culvert up to:

a) 350 m where entry to the pipe sewer or pipe culvert may be obtained at each end of the pipe sewer or culvert;

b) 30 m where rodding is used; or

c) 150 m where a self-propelled laser profiler unit is used when entry is at only one end of the pipe sewer or culvert.

Work shall not commence until the Contract Administrator is satisfied that all items of the inspection equipment have been provided and are in full working order.

Where the laser profiler shall be towed by winch and cable through the pipe sewer or culvert, all winches shall be stable during the entire inspection. All cables shall be of steel or of an equally non-elastic material to ensure the smooth and steady progress of the inspection equipment.

Each laser profiler unit shall have sufficient number of guides and rollers such that, when inspecting, all cables are supported away from the pipe and maintenance hole edges.

All cables and lines used to measure the laser profiler's location within the pipe sewer or culvert shall be maintained in a taut manner and set at right angles, where possible, to run through or over the measuring device.

434.06.03 Certification of Equipment

The laser profiling, observation, and defect measuring equipment shall be certified by a qualified third-party laboratory at a duration recommended by the manufacturer. If the perpendicular position of the laser profiler in relationship to the camera is changed or modified in any way, then the calibration and/or certification is no longer valid.

The qualified third-party laboratory shall also be able to confirm and certify that the laser profiling equipment shall meet or exceed the following criteria in normal usage conditions and not only in a controlled environment by validating the:

a) Device’s precision for the entire profiler’s range of use (0 to 40% of ovality);

b) General function of the device (measurement and localizing deformities);

c) Apparatus to measure “actual” deflections;

d) Measurements being given during the calibration are not manual but are derived in an automatic fashion;

e) Accuracy is at a minimum of 0.5%;

f) Repetitiveness according to a normal distribution curve. The dispersion of results or the difference as compared to the average cannot surpass the 1.96 value, or 2 type low variance which gives an exactness probability of 95% meaning that in 5% of the cases, errors can attain (or slightly surpass) 0.5%; and

g) Measuring capabilities of observations and defects with an accuracy level of precision that match or exceed the following:

    i. for measurements of observations and/or defects less than 25 mm, the tool shall have the precision of 10mm; and

    ii. for measurements of observations and/or defects more than 25 mm, the tool shall have the precision of plus or minus 2mm.

434.06.04 LiDAR Equipment

LiDAR scanning equipment shall be capable of measuring the distances to objects and surfaces in pipes, and shall be capable of imaging pipes from 900mm to 3600mm diameter when used on a tracked platform. The LiDAR shall support 75 kHz scan rates or higher and be according to EN 60825-1 and Class 1; eye-safe for operator safety.

The scanning instrument shall be equipped with a high-speed LiDAR scanner with survey grade accuracy, wide range and field of view, integrated camera and laser plummet. The system shall be a pulsed, proprietary microchip, safe laser with LiDAR scan rates up to 40,000 points per second and a scan resolution of 8mm Guassian-based. LiDAR scanning units that continuously scan around their axis shall have a minimum field of view of 270 degrees.

Data storage shall be internal or external hard drive accessed by a digital notebook or personal computer. Onboard data storage capacity shall be minimum 50GB.

434.07 CONSTRUCTION

434.07.01 General

Standard laser and LiDAR scanning practice shall conform to ASTM F3095.

Operator shall be certified as per NASSCO PACP.

This practice applies to gravity flow lines—storm sewers, sanitary sewers, combined sewers, siphons, edge drains, highway drains, and culverts, and to all other pipelines, ducts and conduits regardless of shape, design configuration or material. The line shall be free of excess debris and obstructions with a maximum flow level or stagnant water, during laser profiling, not to exceed 10 % of nominal pipe diameter or 150 mm in depth, whichever is the lesser.

LiDAR scanning shall be conducted continuously and simultaneously with other inspection technology for the entire length of the pipeline as specified in the Contract Documents. LiDAR equipment shall be moved through the pipeline on a stable transport platform capable of supporting and maintaining the position of the LiDAR inspection equipment above the fluid level. Tracked platforms shall be capable of forward/stop/reverse mobility for detailed high-resolution scans to be collected at a specified interval as specified in the Contract Documents.

The provision of 3D LiDAR scanning provides an accurate determination of pipe geometry above the fluid level. Internal Diameter and Deflection graphs shall be used in conjunction with the integrated and detailed views to precisely quantify internal pipe wall material loss/gain or deformation at a given location and clocking angle. Pipe cross-sections obtained from precision high resolution scans shall be used to provide quantitative information regarding internal pipe diameter, including ovality. Precision Scans are produced with multi-color indication depicting pipe shape deviations from original conditions as well as localized material gain and/or loss.

At the start of each survey, the length of pipe from zero chainage up to the cable calibration point shall be recorded and reported in order to obtain a full record of the pipeline length from the inside face of the access point (i.e.; maintenance hole, valve chamber, etc.) to the inside face of the next access point or outlet end of the pipeline.

The metre reading entered for the cable calibration point shall allow for the distance from the start of the inspection to the cable calibration point such that the metre reading at the start of the inspection is zero.

In the case of surveying through a maintenance hole where a new report sheet is required, the metre reading shall be set at zero with the laser survey instrument focused on the outgoing pipe entrance.

At the start of each survey segment, the following minimum data shall be recorded:

a) An update of the survey equipment position in the pipe sewer or culvert from adjusted zero.

b) Pipe sewer or culvert dimensions.

c) Maintenance hole and pipe length reference numbers.

d) Date of Inspection.

e) Road Name and Location.

f) Direction of Inspection.

g) Time of Start of Inspection.

h) Region or Municipality.

Once the survey is underway, the survey equipment position in the pipe sewer or culvert from zero in metres and tenths of a metre shall be recorded.

The survey shall be continued at the opposite end of the pipe sewer or culvert if a blockage or obstruction is encountered.

434.07.02 Pipeline Cleaning

When specified in the Contract Documents, pipelines shall be cleaned and flushed according to OPSS 411 immediately prior to Survey Inspection.

434.07.03 Accuracy

Verification of laser survey accuracy shall be done on a random basis on a minimum of 10% of the inspection reports submitted.

Precision LiDAR ovality scans including but not limited to Sensor Error, Axis Alignment Error, and Processing Errors shall be accurate to +/- 1 %

LiDAR positioning accuracy shall be < 8mm, distance accuracy shall be < 5mm, and angle accuracy shall be < 15 seconds. Modelling surface accuracy shall be < 5mm. To achieve the required accuracy, the LiDAR instrument shall be equipped with a solid state attitude sensor or dual axis compensators to correct for sensor roll or pitch.

434.07.04 Survey Equipment Position

The survey equipment shall be positioned centrally in a pipeline facing along the longitudinal axis. A method of aligning the laser profiler axis with the longitudinal axis of the pipe shall be demonstrated and employed when surveying for detailed accurate cross-sections in pipes over 900mm diameter.

434.07.05 Survey Equipment Travel Speed

The travelling speed of the survey equipment shall be limited to:

a) 0.10 m/s for pipes of diameter not exceeding 200 mm;

b) 0.15 m/s for pipes of diameters exceeding 200 mm but not exceeding 310 mm; and

c) 0.20 m/s for pipes of diameters exceeding 310 mm

434.07.06 Survey Equipment Location

A suitable metre-measuring process shall be used that enables the cable length to be accurately measured to indicate the location of the survey equipment. The metre-measuring process shall be accurate to ±1% of the length of the pipeline being inspected.

The tolerance shall be demonstrated using one or both of the following methods in conjunction with a linear measurement audit form that shall be completed each day during the inspection:

a) Cable calibration device; or

b) Tape measurement of the surface distance between access points.

If the accuracy of the metre-measuring process fails, it is to be replaced. The Contract Administrator may require that the lengths of pipeline first inspected under the original metre-measuring process be re-inspected using the new metre-measuring process.

434.08 QUALITY ASSURANCE

Upon submission, printed inspection reports and survey accuracy checks shall be reviewed by the Contract Administrator to ensure compliance with the requirements. Any surveyed pipeline deemed unacceptable by the Contract Administrator shall be re-surveyed at no additional cost.

434.08.01 Final Inspection Reporting

For each survey inspection, a printed inspection report generated by the software shall be submitted to the Contract Administrator that clearly identifies the location of defects and observations as per NASSCO coding and related narrative discussion of results.

1. An integrated overview of laser data is to be presented in a color-coded format as an unrolled illustration of the pipe condition above the flow line (9:00 to 3:00 clocking angles inclusive) over the length of the inspection segment. Coded distinctions shall be provided for pipe ID that coincides with expected values, material loss (corrosion) or outward deformations as measured by increasing pipe ID, advanced corrosion or deformation, and material gain (buildup) or inward deformation as measured by decreasing pipe ID.

2. Precision high resolution scan views identifying ovality and deflection shall be presented in a cross-section view where precision scans were taken during the pipe inspection survey with color coding consistent with the other defects. Where the presence of fluids in the pipe necessitates interpolation and estimation, calculations to fill gaps and complete the full circumference view shall be performed. The method and calculations used to support these assumptions as well as their occurrence shall be presented. To support identified radial localization of defects, individual ID measurements as computed from the axis of the inspected pipe shall be presented in an illustrated ovality and deflection graphs covering the length of the inspection segment. All LiDAR high resolution scans obtained during the inspection are to be provided along with the report in a 3D point cloud (VRML) format including software for viewing on a PC. Spacing of cross-sectional views to be determined by Contract Administrator.

3. Measured pipe ID that coincides with expected values shall be coded green. Outward deformations, as measured by increasing pipe ID, shall be colored on a yellow/red color scale, advanced deformation. Material gain (buildup) or inward deformation, as measured by decreasing pipe ID, shall be on a blue color scale.

Survey inspection reports shall be submitted to the Contract Administrator in the following formats, with the noted number of copies, within 15 Business Days of the completion of the fieldwork:

a) 3 copies of the printed defect inspection report.

b) 2 portable hard disk drives, other digital storage devices and software database as specified in the Contract Documents, each containing the identical survey report information as in the printed copies.

Entire inspections shall be contained within one digital file on a digital storage device, as applicable.
When possible, reverse set-up inspections shall be recorded immediately after the original inspection.

434.09 MEASUREMENT FOR PAYMENT

434.09.01 Actual Measurement

Measurement for a Laser/LiDAR Survey of a pipeline shall be measured in metres on the ground surface along the centreline of the pipe from the centre of one access point to the centre of another access point.

In the event that a Laser/LiDAR Survey is abandoned due to a blockage or collapsed pipe or the pipe is inaccessible, measurement shall be in metres for the actual length of pipeline inspected as determined from the chainage indication on the record media.

434.10 BASIS OF PAYMENT

Payment at the Contract price for the Survey work shall be full compensation for all labour, Equipment, and Material to do the work.

Non-compliant submissions returned for correction shall be corrected and resubmitted at no expense to the Owner.

Appendix 434-A, November 2019
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- The content of inspection reports. (434.04.01)

- Forward/stop/reverse mobility of LiDAR equipment. (434.06.03)

- Location of survey. (434.06.03)

- Pipeline cleaning and flushing. (434.07.01)

- The type of media storage. (434.08.01.01)

The designer should ensure that the General Conditions of the Contract and the 100 Series General Specifications are included in the Contract Documents.

- Additional or different labelling information for deliverables including disks and cases.

- Flow control measures, which may include such things as scheduling work for off-peak flow times, plug or block flow at upstream manhole, and temporary by-pass pump flow around inspection section.

- The designer should determine if the following is required and if so, specify it in the Contract Documents:

- If the Contractor is to clean and flush pipelines prior to commencement of pipeline survey.

- If still photographs are required as part of the pipeline survey.

- If LiDAR survey shall be carried out concurrently with a CCTV survey (OPSS 409)

- Final and formal meeting presentation of LiDAR results to representatives of the Owner and/or Contract Administrator

- If LiDAR survey is to provide results in all three X, Y, Z dimensions, specify the GPS control monument to be used and the data reference (example: NAD83 Zone 17)

- Alternate Basis of Payment which may include split payments (example: xx% for completed field work, remaining xx% upon final acceptance of final reports)

Related Ontario Provincial Standard Drawings

No information provided here.

CONSTRUCTION SPECIFICATION FOR SONAR INSPECTIONS OF GRAVITY PIPE SEWERS AND CULVERTS

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435-A Commentary

435.01 SCOPE

This specification covers the requirements for sonar inspections of gravity pipe sewers and culverts.

435.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be as specified in the Contract Documents.

435.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

435.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 409 Construction Specification for Closed-circuit Television (CCTV) Inspection of Pipelines

435.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Bar Check means the measurement by sonar of a known distance.

Cross-section means a cross-section of the pipe produced at set intervals or where there is an area of interest. The cross-section shows pipe size, pipe shape, height of buildup and flow restriction.

Dwell Scan means a 360-degree scan of the inside of a section of the pipe being inspected with the sonar remaining stable relative to the pipe cross-section.

Echo means the reflected sound wave

Frequency means the time period between peaks in a sound wave. High frequency sound attenuates rapidly and provides better resolution due to its shorter wavelength, while low frequency sound is more robust with slightly lower resolution due to its longer wavelength.

NASSCO means North American Society of Sewer Service Companies.

PACP means Pipeline Assessment and Certification Program.

Profiling Sonar means a pencil beam type sound pulse to measure distances where the sonar head mechanically rotates about its' axis creating a profile of a pipe

Profiling Sonar Image means a 2D snapshot of the cross section of a pipe.

Pulse width means the length in microseconds of the transmitted sound pulse. (a short pulse produces finer detail but will attenuate more quickly)

Sonar means the principle used to measure the distance between a source and a target by sound pulse. It is the acronym for Sound Navigation and Ranging.

435.04 DESIGN AND SUBMISSION REQUIREMENTS

435.04.01 Submission Requirements

The following information shall be submitted to the Contract Administrator two weeks prior to the start of a Sonar survey:

a) A sample sonar survey report including, but not limited to the following:
   i. Graphical display of sediment volume and location, sediment levels, and pipe area vs. full design area.
   ii. Graphical display of sediment volume and location, sediment levels, and pipe eccentricity and ovality.
   iii. High Resolution Cross Sectional Scans shall be reported for every 10% length of inspected pipe or every 50m, whichever as listed in the detailed scope of work.
   iv. The data is complied in a format that will be used for calculating changes in sediment depth, sediment volume, sediment accumulation, changes in build-up corrosion rates, and deformation rates when compared to past or future condition assessments.

A Sonar Final Report shall be submitted in hard colour copy and digital format on an external hard drive.

435.04.02 General

Media storage shall be as specified in the Contract Documents.

Digital storage device with minimum USB 2.0 or higher compatibility shall be placed inside envelopes with labels displaying the following information.

a) Owner's Name
b) Contract Number or Project Name
c) Sewer or Culvert Identification Number
d) Region or Municipality
e) Road Name and Location
f) Inspection Date

The digital storage device shall include a file in either Word or text format including the information provided above. The digital storage device shall be labelled. The label shall include the information in points a) and b) above to identify the content.

435.06 EQUIPMENT

Sonar equipment is specifically adapted for use in municipal pipelines using high frequency sound waves to locate and map conditions within the pipe environment creating continuous sonar images displayed and recorded in “real time” mode.

The range resolution measurement error must be no greater than 13mm from a distance of 1-4m and no greater than 20mm from distances of beyond 5m.

The resolution of the sonar inspection equipment shall be as required by the inspection protocol and as specified in Contract Documents.

435.07 CONSTRUCTION

435.07.01 Precision of Sonar Systems

Active sonar ranging is based on emitting a pulse of sound energy to a target surface and measuring the time taken for an echo to return. Based on the speed of sound in water, the distance to the target surface can be calculated. 3D sonar systems assume that the contact point is in the centre of the beam of sound energy when converting the return to a 3D point. Sound energy expands as it propagates through water, however, and a sonar pulse produces returns not only from the centre of the beam but also from any surface in its cone-shaped acoustic beam. The precision of sonar systems is limited because they must approximate a relatively large footprint area with a single point. Details such as cracks that are smaller than the footprint cannot be resolved, and sudden changes in structure such as edges cannot be located more precisely than the size of the footprint.

435.07.02 Survey Reporting

Survey reports shall be submitted to the Contract Administrator in the following formats, with the noted number of copies, within 10 Business Days of the completion of the fieldwork:

a) 3 printed hard copies of the printed inspection report, unless otherwise specified in the Contract Documents.

b) 2 portable digital drives, each containing the identical inspection report information as in the printed copies,

c) 2 copies of the digital video recording in common video formats as specified in the Contract Documents.

Entire inspections shall be contained within one digital folder on a digital storage device, as applicable. When possible, reverse set-up inspections shall be recorded immediately after the original inspection.

Each digital report and video recording file shall contain the file name, as specified in the Contract Documents and may include the following:

a) Tender, Project, or Contract number

b) E<Entity number>

c) F<From entity number>

d) T<To entity number>

e) Street Name, Park Name, or Highway Number

f) M<Measured length> (provided by Contract, to nearest meter – no decimals)

g) I<Inspected length> (experienced in field, to nearest meter – no decimals)

h) <Inspection direction: DS or US> (downstream or upstream)

i) <Letter designating inspection sequence> (“A” indicates partial inspection that would include a “B” or more to this entity for a complete manhole to manhole inspection)

The file format will follow the pipe inspection file name to signify a report or video recording.

The only time a “period” or “dot” is to be used is prior to the file format designation.

For example: “910-200_ESP729_F5328_T5350_BERRY_ST_M150_I39_US_B.MPEG” indicates that this is from contract 910-200, the pipe segment is referred to as SP729, inspection is from MH 5328 to MH 5350 on Berry Street, records say 150m long, actual inspection was 39m in the upstream deployment, and this is the second or “B” partial inspection of this entity, 39m long, of this video recording.

All required header information fields shall be completed and verified for correctness. The software used to produce the inspection report shall not allow the operator to continue inputting information until the preceding field has been completed. The report shall be printed and presented according to the contract specifications.

NASSCO PACP 7.0.3 Header Mandatory Fields include:

a) Surveyed By:

b) Certificate No.

c) Date (YYYYMMDD)

d) Sheet Number (only relevant to NASSCO certified software, maybe not in this document)

e) Pre-Cleaning (default for Sonar would be “no”)

f) Direction of Survey

g) Inspection Status (default for Sonar would be “complete inspection (CI)”)

h) Street (Name & Number)

i) City

j) Pipe Use (SS=Sanitary, SW=Stormwater, CB=Combined, FM=Forcemain, etc.)

k) Height (Diameter)

l) Width (mandatory if pipe shape is not circular)

m) Shape

n) Material

o) Upstream MH No.

p) Downstream MH No.

All dimensions in the inspection report shall be in metric.

435.08 QUALITY ASSURANCE

435.08.01 Calibration

The Sonar shall be calibrated with the appropriate speed of sound for the medium it is being operated in. This shall be demonstrated by means of a Bar Check.

435.08.02 Setup Demonstration

The means used to ensure that the sonar profile image was taken exactly perpendicular to the longitudinal axis of the pipe shall be demonstrated.

435.09 MEASUREMENT FOR PAYMENT

435.09.01 Actual Measurement

Measurement for a Sonar survey of pipeline shall be measured in metres along the centreline of the pipe sewer from the centre of one drainage structure to the centre of another drainage structure or outlet end of the pipe sewer. Measurement for pipe culverts shall be from one end of the pipe culvert to the other end of the pipe.

In the event that a Sonar survey is terminated due to a blockage or collapsed pipe or the pipe is inaccessible, measurement shall be in metres for the actual length of pipeline inspected as determined from the chainage indication on the record media.

Payments for additional scans shall be made on a per sonar scan basis.

435.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clause under Actual Measurement.

435.10 BASIS OF PAYMENT

435.10.01 Sonar Survey - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Appendix 435-A, November 2019
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Specify a resolution (e.g. *Range Resolution better than 0.5% of distance measured*, etc.) (435.06)

- File name to be used by contractor for naming the digital files (435.07.02)

The provision of Sonar scanning as an inspection component for the condition assessment of a pipeline allows for accurate determination of conditions below the fluid level encountered during an in-pipe inspection.

A thorough understanding of pipe eccentricity and corrosion is gained by examining sonar cross sectional dwell images. Each dwell scan includes multiple sonar scans at a particular location. The information from the multiple scans is combined to create a more complete picture of the pipe condition. Each dwell scan can be viewed as an image. In the form of an image, bright colors represent strong returns. Sonar dwell scans are taken in both fully and partially charged pipe however, sonar works best in submerged conditions.

In fully charged pipes Eccentricity, Collapse Percent, and Corrosion can be measured using dwell scans. In partially charged pipes it is possible to measure these pipe metrics for certain charge levels; less information can be ascertained about eccentricity, collapse, and corrosion as charge levels decrease.

In consideration of advancements in technology, the use of multi-beam profiling sonars for data acquisition and generation of 3D models of pipe interiors shall be allowed on a site-specific basis.

CONSTRUCTION SPECIFICATION FOR LOCATING GRAVITY PIPE SEWERS

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436-A Commentary

436.01 SCOPE

This specification covers the requirements for locating existing gravity pipe sewers using locating methods such as, but not limited to, Ground Penetrating Radar (GPR), Sonde, and Inertial Navigation Systems (INS).

The purpose of this specification is to detail the utilization of an in-pipe positioning system to obtain absolute XYZ pipeline position for buried infrastructure providing horizontal and elevation geospatial data that can be imported into a commonly used geographic information system (GIS) or CAD system.

This specification pertains to part or all of an installation of underground utility infrastructure where measurements of the precise location and depth of the utility infrastructure cannot be obtained by sight or exposed by daylighting.

436.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be as specified in the Contract Documents.

436.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

436.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

American Society of Civil Engineers

ASCE C-I 38-02 Standard Guideline for the Collection and Depiction of Existing Subsurface Utility Data

Canadian Common Ground Alliance

Underground Infrastructure Damage Prevention

Canadian Standards Association

CSA S250-11 Mapping of Underground Utility Infrastructure

436.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Dead Reckoning means the process of calculating a probe's location by using its previously determined location and advancing that location based on known or estimated speeds over an elapsed time and course.

Ground Penetrating Radar (GPR) means a geophysical method that uses radar pulses to image the subsurface.

Inertial Navigation System (INS) means a navigation device that uses a computer, motion sensors, and rotation sensors to continuously calculate by Dead Reckoning the position, the orientation, and the velocity of a moving object without the need for external references.

Sonde means an instrument probe that automatically transmits information about its location underground and underwater.

436.04 DESIGN AND SUBMISSION REQUIREMENTS

The mapping of the alignment and elevation of the installed pipe shall be completed to provide continuous, three-dimensional positional data of the pipe. The mapping shall be done using a survey method that is suitable for a trenchless installation and records position continuously throughout the survey and is capable of providing the invert, top or centerline of the pipe, as directed by the Engineer prior to the time of mapping.

Persons responsible for measuring and documenting information shall be competent individuals that follow recognized procedures for field measurements and subsequent transfer to mapping drawings.

Registering and correcting the in-pipe orientation measurement probe shall be achieved by a survey (accurate to plus or minus 0.10 m) of the start and end point along the pipeline route. For longer sections, an intermediate point shall be provided every 100m or less. This GPS survey shall be completed by a qualified professional.

Horizontal and vertical location shall be provided in reference to the coordinate system and datum as specified in the Contract Documents.

Access locations shall be as specified in the Contract Documents.

When creating as-built records, the spatial accuracy of the data shall meet CSA Standard S250, Record Accuracy Level 2 where the position shall be accurate to +/- 100mm in the x, y, and z coordinates.

Proof of calibration of the measurement system within the past 12 months from the date of actual survey shall be mandatory and submitted to the Engineer for acceptance prior to commencement of the survey.

The final report and deliverables shall include the following:

a) A detailed description of the mapping data features and their attributes or fields (i.e. feature metadata), including design and/or baseline values for individual attributes, sufficient to allow the recipient to verify that the data received corresponds to the prescribed format; and

b) Supporting data tables that could be linked to other feature data tables that define data relationships and dependencies; and

c) Specifications of the software used to create and edit the features found in the electronic mapping data, including versions and data file formats; and

d) The pipe position data shall be converted and provided to a format that is compatible with the software as specified in the Contract Documents, and have the ability to be seamlessly uploaded to a referenced base drawing as specified in the Contract Documents. A PDF version of the survey shall also be included; and

e) The pipe position data shall also be converted to a Comma Separated Value (*.csv) format.

f) All field logs shall be submitted in non-proprietary format.

g) Pipe location to be marked in field as specified in the Contract Documents.

436.06 EQUIPMENT

The locating system tolerance shall meet the requirements of CSA S250, Record Accuracy Level 2 (+/- 100mm in the X, Y and Z coordinates).

436.08 QUALITY ASSURANCE

Proof of calibration of the measurement system within the past 12 months from the date of actual survey shall be mandatory and submitted to the Engineer for acceptance prior to commencement of the survey.

436.09 MEASUREMENT FOR PAYMENT

Payment shall be made on the basis of length of piping surveyed. Measurement shall be to the closest linear metre. Payment shall include GPS services, data analysis and final reporting.

436.10 BASIS OF PAYMENT

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

If no pipe is found, then the terms of payment shall be negotiated with the Owner.

Appendix 436-A, November 2019
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Access Requirements/Limitations (436.04)

- Provide the coordinate system and datum used by the Owner. (436.04)

- Software used by the Owner. (436.04)

- Provide a referenced base drawing. (436.04)

- Pipe locations (436.04)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

CONSTRUCTION SPECIFICATION FOR MANDREL DEFLECTION INSPECTIONS

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438-A **Commentary**

438.01 SCOPE

This specification covers the requirements for mandrel deflection inspections of flexible gravity pipe sewers and culverts.

438.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be as specified in the Contract Documents.

438.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

438.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 410 Construction Specification for Pipe Sewer Installation in Open Cut, Field Testing – Deflection Testing of Pipe Sewers

OPSS 411 Construction Specification for the Cleaning and Flushing of Pipe Sewers, Catchbasins, Maintenance holes, Ditch Inlets, and Oil-Grit Separators

Canadian Standards Association

CSA B182.11 Standard practice for the installation of thermoplastic drain, storm, and sewer pipe and fittings

438.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

PACP means Pipeline Assessment and Certification Program.

438.04 DESIGN AND SUBMISSION REQUIREMENTS

The following information shall be submitted to the Contract Administrator two weeks prior to the start of mandrel deflection inspection operations:

a) The name of the inspection firm staff member who will be responsible for conducting the mandrel deflection inspections of the flexible gravity pipe sewer or culvert installations.

b) A separate sample inspection report.

c) The details of the accuracy verification system that is used to verify inspection accuracy.

Inspection reports submitted shall have at least the following information in the title or as otherwise specified:

a) Owner's Name

b) Contract Number or Project Name

c) Pipe Sewer or Culvert Identification Numbers

d) Region or Municipality

e) Road Name and Location

f) Inspection Date

Photographs are to be in colour with a minimum image size of 90 x 70 mm and shall be reproduced on premium glossy photo quality paper or digital image in MPEG as specified in Contract Documents.

438.04.01 Final Documentation

438.04.01.01 Inspection Reporting

Deflection inspection reports shall be submitted to the Owner in the following formats, with the noted number of copies, within 5 Business Days of the completion of the fieldwork:

a) 3 copies of the printed deflection inspection report.

b) Digital files as specified in Contract Documents.

Entire inspection reports shall be contained within one digital file on a single CD or DVD, as applicable. Where possible, any reverse set-up inspections shall be immediately after the original inspection.

All dimensions in the inspection report shall be metric.

The inspection report shall identify locations of deflections in the pipe sewer or culvert and the associated pipe condition codes. The inspection report shall include photographs when the need for photographs is specified.

438.04.02 Drawings

One clean set of the Contract Drawings showing maintenance hole numbers that coincide with the inspection report shall be returned to the Contract Administrator on completion of the inspection. The drawings shall be clearly annotated to show any discrepancies between the drawings and the inspection report. Such discrepancies shall be brought to the attention of the Contract Administrator during the inspection.

The drawings shall be clearly marked displaying the pipe deflection categories for all locations where pipe sewers or culverts were inspected.

438.06 EQUIPMENT

Mandrels used to inspect the flexible pipe sewers or culverts shall have been used exclusively for flexible pipe inspections.

Mandrels shall be cylindrical in shape, and constructed with an odd number of evenly spaced arms or prongs, minimum 9 in number. The rigid mandrel shall be constructed of a metal or a rigid plastic material that can withstand 1.38 MPa (200 psi) without being deformed. The contact length of the mandrel shall be measured between the points of contact on the mandrel arm or between sets of prongs. This length shall not be less than that shown in Table 1. The rigid mandrel may or may not have adjustable or collapsible legs, which would allow reduction in mandrel diameter during testing.

The minimum diameter of the circle scribed around the outside of the mandrel arms shall be equal to the allowable deflected pipe diameter ±1 mm. Refer to Tables 2, 3 and 4 for the allowable 5%, 7.5% and 10% deflective measurements for PVC, HDPE, PP and steel pipe products.

The mandrel shall be checked with a go-no-go proving ring. The proving ring shall have a diameter equal to the allowable deflected pipe diameter ± 0.1 mm. An acceptable mandrel shall not pass through the proving ring. The proving ring shall be fabricated from steel a minimum of 6 mm thick.

438.07 CONSTRUCTION

438.07.01 General

The sewer line shall be cleaned and flushed prior to mandrel deflection inspections in accordance with OPSS 411.

A string line shall be installed inside the sewer line by means of an air blower or pulling it through the line with a remote control small-wheeled vehicle.

After the string line is installed a larger piece of rope shall be tied to the string line and pulled back through the pipe.

438.07.02 Mandrel testing

Larger mandrels that will not fit through the manhole opening, shall be assembled inside the structure. To do this:

a) Loosen One of the end caps on the slotted shaft shall be loosened.

b) The point of a fin shall be inserted into the slot near the tight end cap. the other point of the fin shall be slipped under the loose cap.

c) This action shall be repeated until all of the fins are in place.

d) A bungee cord wrapped around the loose fins may be required to help hold the fins in place while inserting consecutive fins.

Once the mandrel is assembled, a rope shall be tied to each end of it, so if the mandrel fails to pass through the pipe it can be retrieved. If the mandrel fails to pass, the test has failed. See Table 6 for next steps.

No vehicle or power winches shall be used to pull it through, as the excess force can damage the mandrel and/or the pipe.

438.08 QUALITY ASSURANCE

Upon submission, printed inspection reports, and deflection accuracy checks shall be reviewed to ensure compliance with the requirements.

Submittals shall be reviewed by the Contract Administrator and their acceptance confirmed within 5 Business Days of submission. Non-compliant submissions will be returned for correction. Corrected submissions shall be returned to the Contract Administrator for review within 5 Business Days.

438.08.01 General

Mandrel inspections shall be done by the inspection firm in accordance with the pipe condition coding practices as they pertain to deflection as outlined in the inspection firm PACP.

Deflection inspections shall be performed on pipe sewers or culverts, constructed using flexible pipe materials, as selected by the Contract Administrator.

Mandrels and associated appurtenances shall be capable of assessing a length of pipe sewer or culvert up to:

a) 350 m where entry to the pipe sewer or culvert may be obtained at each end of the pipe sewer or culvert;

b) 30 m where rodding is used; or

c) 150 m where a self-propelled mandrel unit is used when entry is at only one end of the pipe sewer or culvert.

Work shall not commence in a work shift until the Contract Administrator is satisfied that all items of the inspection equipment have been provided and are in full working order.

Where the mandrel shall be towed by winch and cable through the pipe sewer or culvert, all winches shall be stable during the entire inspection. All cables shall be of steel or of an equally non-elastic material to ensure the smooth and steady progress of the inspection equipment.

Each mandrel unit shall have sufficient number of guides and rollers such that, when inspecting, all cables are supported away from the pipe and maintenance hole edges.

All cables and lines used to measure the mandrel's location within the pipe sewer or culvert shall be maintained in a taut manner and set at right angles, where possible, to run through or over the measuring device.

All selected flexible pipe sewer or culvert installations shall have the mandrel pulls performed 1 to 3 times as required. The “Fail” status after a pull is completed constitutes the need for subsequent pulls at the next deflection limit as defined in Table 5.0.

Pipe sewers or culverts failing the 10% pull test will not to be tested further.

Deflected pipe diameter is calculated as a % deflection from the base inside diameter of the pipe. The four basic pipe deflection categories are as follows:

i) < 5% and associated pipe lengths;

ii) > 5% and < 7.5% and associated pipe lengths;

iii) > 7.5% and < 10% and associated pipe lengths; and

iv) > 10% and associated pipe lengths.

Base inside diameter of the pipe is the average inside diameter minus statistical tolerances.

Deflections in each pipe sewer or culvert shall be recorded according to the pipe deflection categories as noted above. Any variation from these deflection limits shall be noted in the inspection report.

438.08.02 Deflection Accuracy

Prior to commencement of the mandrel inspection operations, a formal deflection accuracy verification system shall be submitted to the Contract Administrator, and implemented when approved. The deflection accuracy verification system shall be prepared for the deflection testing using a mandrel that will be employed on the Contract by the inspection firm.

Verification of deflection accuracy shall be done on a random basis on a minimum of 10% of the inspection reports submitted.

Deflection accuracy checks shall be submitted to the Contract Administrator along with any corresponding reports.

438.08.03 Deflection Inspection

The work shall include all mandrel inspections of the gravity pipe sewers or culverts selected for inspection and the preparation of all written reports.

Each mandrel used shall have an accepted sample submissions report approved prior to being used for any inspection work.

At the start of each pipe sewer or culvert being inspected, the length of pipe sewer or culvert from zero chainage up to the cable calibration point shall be recorded and reported in order to obtain a full record of the: pipe sewer or culvert length from the inside face of the maintenance hole to the inside face of the next maintenance hole or outlet end of the pipe sewer or culvert.

The metre reading entered for the cable calibration point shall allow for the distance from the start of the inspection to the cable calibration point such that the metre reading at the start of the inspection is zero.

In the case of inspecting through a maintenance hole where a new report sheet is required, the metre reading shall be set at zero with the deflection instrument focused on the outgoing pipe entrance.

At the start of each maintenance hole length, a record of data containing the following minimum information:

a) An update of the mandrel's position in the pipe sewer or culvert from adjusted zero.

b) Pipe sewer or culvert dimensions.

c) Maintenance hole and pipe length reference numbers.

d) Date of Inspection.

e) Road Name and Location.

f) Direction of Inspection.

g) Time of Start of Inspection.

Once the inspection of the maintenance hole length is underway, an update of the mandrel's position in the pipe sewer or culvert from zero in metres and tenths of a metre shall be recorded.

The mandrel shall be stopped when it cannot proceed further due to blockage or obstruction. The inspection shall be restarted at the opposite end of the pipe sewer or culvert if a blockage or obstruction is encountered.

438.08.04 Mandrel Position

The mandrel shall be positioned centrally in a circular pipe sewer or culvert.

In all instances the mandrel shall be positioned facing along the longitudinal axis of the pipe sewer or culvert.

438.08.05 Mandrel Travel Speed

The travelling speed of the mandrel in the pipe sewer or culvert shall be limited to:

a) 0.1 m/s for pipes of diameter less than 200 mm;

b) 0.15 m/s for pipes of diameters exceeding 200 mm but not exceeding 310 mm; and

c) 0.20 m/s for pipes of diameters exceeding 310 mm

438.08.06 Mandrel Position Location

A suitable metre-measuring process shall be used that enables the cable length to be accurately measured to indicate the location of the mandrel. The metre-measuring process shall be accurate to ±1% of the length of the pipe sewer or culvert being inspected.

The tolerance shall be demonstrated using one or both of the following methods in conjunction with a linear measurement audit form that shall be completed each day during the inspection:

a) Cable calibration device; or

b) Tape measurement of the surface distance between drainage structures.

If the accuracy of the metre-measuring process fails, it is to be replaced. The Contract Administrator may require that the lengths of pipe sewer or culvert first inspected under the original metre-measuring process be re-inspected using the new metre-measuring process.

438.09 MEASUREMENT FOR PAYMENT

438.09.01 Actual Measurement

Measurement for a Mandrel test of pipeline shall be measured in metres along the centreline of the pipe sewer from the centre of one drainage structure to the centre of another drainage structure or outlet end of the pipe sewer. Measurement for pipe culverts shall be from one end of the pipe culvert to the other end of the pipe.

In the event that a Mandrel test is terminated due to a blockage or collapsed pipe or the pipe is inaccessible, measurement shall be in metres for the actual length of pipeline inspected as determined from the chainage indication on the record media.

438.09.01 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clause under Actual Measurement.

438.10 BASIS OF PAYMENT

438.10.01 Mandrel Test - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Table 1
Deflection Testing of Flexible Pipe Installations

Nominal Pipe Size mm	Mandrel Contact Length mm
150	100
200	150
250	200
300	250
350	300
375	300
400	300
450	350
500	400
525	450
600	500
675	575
750	675
900	750
1050	900
1200	1050

Table 2
Deflection Testing of PVC Pipes using Mandrels

Nominal Pipe Size	Pipe Base Inside Diameter	Allowable Deflection 5%	Allowable Deflection 7.5%	Allowable Deflection 10%	Nominal Pipe Size	Pipe Base Inside Diameter	Allowable Deflection 5%	Allowable Deflection 7.5%	Allowable Deflection 10%
mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
SDR 28 PVC Pipe					**SDR 41 PVC Pipe**				
100	96.81	91.97	89.55	87.13	375	360.69	342.66	333.64	324.62
135	129.55	123.07	119.83	116.60	450	440.85	418.81	407.79	396.77
150	144.00	136.80	133.20	129.60	525	519.75	493.76	480.77	467.78
SDR 35 PVC Pipe					600	584.71	555.47	540.86	526.24
100	98.40	93.48	91.02	88.56	750	754.91	717.16	698.29	679.42
135	131.71	125.12	121.83	118.54	900	903.42	858.25	835.66	813.08
150	146.50	139.18	135.51	131.85	1050	1049.55	997.07	970.83	944.60
200	196.11	186.30	181.40	176.50	1200	1198.07	1138.17	1108.21	1078.26
250	245.16	232.90	226.77	220.64	**PVC Pipe - smooth inside ribbed outside**				
300	291.86	277.27	269.97	262.67	200	196.11	186.30	181.40	176.50
375	357.25	339.39	330.46	321.53	250	245.19	232.93	226.80	220.67
450	436.64	414.81	403.89	392.98	300	291.75	277.16	269.87	262.58
525	514.77	489.03	476.16	463.29	375	357.28	339.42	330.48	321.55
600	579.11	550.15	535.68	521.20	450	438.70	416.77	405.80	394.83
675	652.64	620.01	603.69	587.38	525	515.75	489.96	477.07	464.18
750	747.68	710.30	691.60	672.91	600	584.17	554.96	540.36	525.75
900	894.77	850.03	827.66						
1050	1039.51	987.53	961.55						

Pipe base inside diameters are taken from CSA B182.2 and CSA B182.4.

Table 3
Deflection Testing of HDPE Pipes using Mandrels

Nominal Pipe Size	Pipe Base Inside Diameter	Allowable Deflection 5%	Allowable Deflection 7.5%	Allowable Deflection 10%	Nominal Pipe Size	Pipe Base Inside Diameter	Allowable Deflection 5%	Allowable Deflection 7.5%	Allowable Deflection 10%
mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
Corrugated HDPE smooth inside Class 210 and 320 kPa					**HDPE smooth inside/outside RSC 250 and 400**				
100	97.56	92.68	90.24	87.80	840	840	798.00	777.00	756.00
150	146.34	139.02	135.36	131.71	910	910	864.50	841.75	819.00
200	195.13	185.37	180.50	175.62	1020	1020	969.00	943.50	918.00
250	243.91	231.71	225.62	219.52	1070	1070	1016.50	989.75	963.00
300	292.69	278.06	270.74	263.42	1220	1220	1159.00	1128.50	1098.00
375	365.85	347.56	338.41	329.27	1370	1370	1301.50	1267.25	1233.00
450	439.03	417.08	406.10	395.13	1520	1520	1444.00	1406.00	1368.00
525	512.20	486.59	473.79	460.98	1680	1680	1596.00	1554.00	1512.00
600	585.38	556.11	541.48	526.84	1830	1830	1738.50	1692.75	1647.00
750	731.73	695.14	676.85	658.56	1980	1980	1881.00	1831.50	1782.00
900	878.08	834.18	812.22	790.27	2130	2130	2023.50	1970.25	1917.00
1050	1024.42	973.20	947.59	921.98	2290	2290	2175.50	2118.25	2061.00
1200	1170.77	1112.23	1082.96	1053.69	2440	2440	2318.00	2257.00	2196.00
1350	1317.12	1251.26	1218.34	1185.41	2740	2740	2603.00	2534.50	2466.00
1500	1463.46	1390.29	1353.70	1317.11	3050	3050	2897.50	2821.25	2745.00

*Pipe inside diameters for corrugated HDPE smooth inside Class 210 and 320 kPa are taken from CSA B182.8, Table B.1.
**Pipe inside diameters for HDPE smooth inside/outside RSC 250 and 400 are based on manufacturer's submitted pipe availability list as contained in the MTO Gravity Pipe Design Guidelines, December 2008.

Table 4
Deflection Testing of PP Pipes using Mandrels

Nominal Pipe Size	Pipe Base Inside Diameter	Allowable Deflection 5%	Allowable Deflection 7.5%	Allowable Deflection 10%	Nominal Pipe Size	Pipe Base Inside Diameter	Allowable Deflection 5%	Allowable Deflection 7.5%	Allowable Deflection 10%
mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
Corrugated PP smooth inside*					**PP smooth inside/outside****				
300	296.2	281.4	274.0	266.6	750	739.3	702.3	683.9	665.4
375	369.9	351.4	342.2	332.9	900	885.2	840.9	818.8	796.7
450	445.5	423.2	412.1	401.0	1050	1033.1	981.4	955.6	929.8
525	517.4	491.5	478.6	465.7	1200	1181.4	1122.3	1092.8	1063.3
600	593.9	564.2	549.4	534.5	1350	1320.1	1254.1	1221.1	1188.1
750	741.7	704.62	686.1	667.5	1500	1467.5	1394.1	1357.4	1320.8

*Pipe inside diameters for corrugated PP smooth inside are taken from CSA B182.13, Table B.1
**Pipe inside diameters for corrugated PP smooth inside/outside are taken from CSA B182.13, Table B.2

Table 5
Deflection Testing of Steel Pipes using Mandrels

Nominal Pipe Size mm	Pipe Base Inside Diameter mm	Allowable Deflection 5% mm	Allowable Deflection 7.5% mm	Allowable Deflection 10% mm	Nominal Pipe Size mm	Pipe Base Inside Diameter mm	Allowable Deflection 5% mm	Allowable Deflection 7.5% mm	Allowable Deflection 10% mm
Corrugated Steel Pipe - Corrugations 38x6.5									
150	144	137	133	130	250	244	232	226	220
200	194	184	179	175					
Corrugated Steel Pipe - Corrugations 68x13									
300	294	279	272	265	900	894	849	827	805
400	394	374	364	355	1000	994	944	919	895
450	444	422	411	400	1200	1194	1134	1104	1075
500	494	469	457	445	1400	1393	1323	1289	1254
600	594	564	549	535	1600	1592	1512	1473	1433
700	694	659	642	625	1800	1791	1701	1657	1612
800	794	754	734	715	2000	1990	1891	1841	1791
Corrugated Steel Pipe - Corrugations 125x25									
1200	1194	1134	1104	1075	2000	1990	1891	1841	1791
1400	1393	1323	1289	1254	2200	2189	2080	2025	1970
1500	1493	1418	1381	1344	2400	2388	2269	2209	2149
1600	1592	1512	1473	1433	2700	2687	2553	2485	2418
1800	1791	1701	1657	1612	3000	2985	2836	2761	2687
Spiral Rib Steel Pipe – Corrugations 19x19x190 (To be used with joints with external couplers only)									
450	444	422	411	400	1000	994	944	919	895
500	494	469	457	445	1050	1044	992	966	940
525	519	493	480	467	1200	1194	1134	1104	1075
600	594	564	549	535	1350	1343	1276	1242	1209
675	669	636	619	602	1400	1393	1323	1289	1254
700	694	659	642	625	1500	1493	1418	1381	1344
750	744	707	688	670	1600	1592	1512	1473	1433
800	794	754	734	715	1800	1791	1701	1657	1612
825	819	778	758	737	2000	1990	1891	1841	1791
900	894	849	827	805	2200	2189	2080	2025	1970
975	969	921	896	872	2400	2388	2269	2209	2149
					2600	2587	2458	2393	2328

Pipe inside diameters are based on manufacturer's submitted pipe availability list as contained in the MTO Gravity Pipe Design Guidelines, December 2008.

Table 6
Mandrel Deflection Testing Procedure

Pull Occurrence	Deflection Limit						Deflection Test Completed	
	5%		7.5%		10%			
Pipe Diameter	≤ 750	> 750	≤ 750	> 750	≤ 750	> 750	≤ 750	> 750
Pull 1	Pass	Pass					Yes	Yes
Pull 2	Fail	Fail	Pass	Pass*			Yes	Yes
Pull 3	Fail		Fail		Pass**		Yes	

* A subsequent mandrel pull upon the failure to pass the 7.5% deflection test for pipes greater than 750 mm in diameter is not required as these failed pipes have received a “Rejection” pipe condition status and shall be replaced.

** A subsequent mandrel pull upon the failure to pass the 10% deflection test for pipes less than 750 mm in diameter is not required as these failed pipes have received a “Rejection” pipe condition status and shall be replaced.

Appendix 438-A, November 2019
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Photographs. (438.04)

- Digital storage format. (438.04.01.01)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

CONSTRUCTION SPECIFICATION FOR DIRECT MEASUREMENT INSPECTIONS

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439.08 QUALITY ASSURANCE

439.09 MEASUREMENT FOR PAYMENT

439.10 BASIS OF PAYMENT

APPENDICES

439-A Commentary

439.01 SCOPE

This specification covers the requirements for direct measuring diameter variations within existing pipe sewers and culverts.

439.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be as specified in the Contract Documents.

439.01.02 Appendices Significance and Use

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The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

439.04 DESIGN AND SUBMISSION REQUIREMENTS

439.04.01 Submission Requirements

The following information shall be submitted to the Contract Administrator, two weeks prior to the start of Direct Measurement inspection:

a) The name of the inspector who will be responsible for conducting the direct measurement inspections of the gravity pipe sewer or culvert installations.

b) A separate sample inspection report.

c) The details of the accuracy verification system that is used to verify inspection accuracy.

Inspection reports submitted shall have at least the following information in the title or as specified in the Contract Documents:

a) Owner's Name.

b) Contract Number or Project Name.

c) Sewer or Culvert Identification Number.

d) Maintenance hole Identification Number.

d) Region and Municipality.

e) Road name and location.

f) Inspection Date.

Photographs are to be in colour with a minimum image size of 90 x 70 mm and shall be reproduced on premium glossy photo quality paper or digital image.

439.04.02 Final Documentation

439.04.02.01 Inspection Reporting

Direct measurement inspection reports shall be submitted to the Contract Administrator within 5 Business Days of the completion of the fieldwork.

Direct measurement inspection reports shall be submitted in the following formats, with the noted number of copies:

a) 3 copies of the printed inspection report.

b) Digital media as specified in Contract Documents each containing the identical inspection report information as in the printed copies.

Entire inspection report shall be contained within one digital file on a single digital media, as applicable. Wherever possible, any reverse set-up inspections shall be immediately after the original inspection.

All dimensions in the inspection report shall be metric.

The inspection report shall identify locations of defects and deflections in the pipe sewer or culvert and the associated pipe condition codes.

The inspection report shall include photographs when the need for photographs is specified in the Contract Documents.

439.04.02.02 Drawings

One clean set of the Owner's drawings showing maintenance hole numbers that coincide with the inspection report shall be returned to the Contract Administrator on completion of the inspection. The drawings shall be clearly annotated to show any discrepancies between the drawings and the inspection report. Such discrepancies shall be brought to the attention of the Contract Administrator during the inspection.

The drawings shall be clearly marked displaying the pipe condition codes for all locations where pipe sewers or culverts were inspected.

439.06 EQUIPMENT

439.06.01 Inspection Equipment

Direct measuring devices can be a measuring tape, pre-measured rod or some other type of device that can measure the deflections within a pipe sewer or culvert.

Direct measurement and associated appurtenances shall be capable of assessing a length of pipe sewer or culvert up to:

a) 350 m where entry to the pipe sewer or culvert may be obtained at each end of the pipe sewer or culvert;

b) 30 m where rodding is used; or

c) 150 m where entry is at only one end of the pipe sewer or culvert.

Work shall not commence in a work shift until the Contract Administrator is satisfied that all items of the inspection equipment have been provided and are in full working order.

439.08 QUALITY ASSURANCE

Upon submission, inspection reports, and accuracy checks shall be reviewed by the Owner to ensure compliance with the requirements.

439.08.01 Inspection

Direct measurement inspections shall be performed on pipe sewers or culverts, as selected by the Contract Administrator.

The inspection will measure and report defects in a pipe sewer or culvert.

Direct measurements shall be performed using personnel to enter the pipe sewer or culvert to perform the appropriate measurements.

Measurements shall be made diametrically inside the pipe and along the length of the pipe sewer or culvert.

The diametric locations, based on clock face numerals, are as follows:

a) 12 to 6;

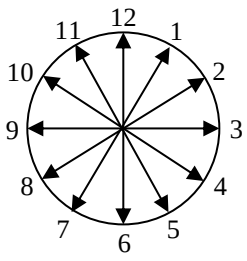
b) 1 to 7;

c) 2 to 8;

d) 3 to 9;

e) 4 to 10; and

f) 5 to 11.



Measurements shall be made along the length of the pipe at 3.0 m intervals. Where pipe shape or deflection changes abruptly within a 3.0 m section, additional measurements shall be made as appropriate until pipe shape or deflection becomes constant.

Measurements shall also be made at all joints that are offset or display gaps between pipe lengths.

439.08.01.01 Direct Measurement Accuracy

Prior to commencement of the direct measurement inspection operations, a formal accuracy verification system shall be submitted to the Contract Administrator, and implemented when approved. The accuracy verification system shall be prepared for the direct measurement testing using measuring devices that will be employed on the Contract by the inspection firm.

Verification of direct measurement accuracy shall be done on a random basis on a minimum of 10% of the inspection reports submitted.

Direct measurement accuracy checks shall be submitted to the Contract Administrator along with any corresponding reports.

439.08.01.02 General

The work shall include all direct measurement inspections of the flexible gravity pipe sewers or culverts selected for inspection and the preparation of all written reports.

At the start of each pipe sewer or culvert being inspected, the length of pipe sewer or culvert from zero chainage up to the direct measurement point shall be recorded and reported in order to obtain a full record of the pipe sewer or culvert length from the inside face of the maintenance hole to the inside face of the next maintenance hole or outlet end of the pipe sewer or culvert.

The position entered for the direct measurement point shall allow for the distance from the start of the inspection to the direct measurement point such that the metre reading at the start of the inspection is zero.

In the case of inspecting through a maintenance hole where a new report sheet is required, the metre reading shall be set at zero with the direct measurement direction focused on the outgoing pipe entrance.

At the start of each maintenance hole length, a record of data containing the following minimum information:

a) An update of the direct measurement's position in the pipe sewer or culvert from adjusted zero.

b) Pipe sewer or culvert dimensions.

c) Maintenance hole and pipe length reference numbers.

d) Date of Inspection.

e) Road name and location.

f) Direction of Inspection.

g) Time of start of Inspection.

Once the inspection of the maintenance hole length is underway, an update of the direct measurement's position in the pipe sewer or culvert from zero in metres and tenths of a metre shall be recorded.

The direct measurement inspection shall be stopped when it cannot proceed further due to blockage or obstruction. The inspection shall be restarted at the opposite end of the pipe sewer or culvert if a blockage or obstruction is encountered.

439.08.01.03 Direct Measurement Device Position

The centre of the direct measurement device shall be positioned centrally in a circular pipe sewer or culvert to obtain diametric dimensions.

439.08.01.04 Direct Measurement Position Location

A suitable position-measuring process shall be used that enables the direct measurement position to be accurately measured to indicate the location of the direct measurement point. The position-measuring process shall be accurate to ±1% of the length of the pipe sewer or culvert being inspected.

The tolerance shall be demonstrated using one or both of the following methods in conjunction with a linear measurement audit form that shall be completed each day during the inspection:

a) Cable calibration device; or

b) Tape measurement of the surface distance between structures.

439.09 MEASUREMENT FOR PAYMENT

Measurement of pipe being surveyed shall be by length in metres over the inspection length.

439.10 BASIS OF PAYMENT

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Appendix 439-A, November 2019
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Information required for the title, when submitting the Inspection Reports. (439.04.01)

- Identify if the photographs are needed or not. (439.04.02.01)

- Digital media. (439.04.02.01)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

CONSTRUCTION SPECIFICATION FOR WATERMAIN INSTALLATION IN OPEN CUT

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441-A **Commentary**

441.01 SCOPE

This specification covers the requirements for the installation of watermains, service connections, and associated appurtenances in open cut.

441.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be as specified in the Contract Documents.

441.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

441.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 206	Grading
OPSS 401	Trenching, Backfilling, and Compacting
OPSS 404	Support Systems
OPSS 442	Corrosion Protection of New and Existing Watermains
OPSS 490	Site Preparation for Pipeline, Utilities, and Associated Structures
OPSS 491	Preservation, Protection, and Reconstruction of Existing Facilities
OPSS 492	Site Restoration Following Installation of Pipelines, Utilities, and Associated Structures
OPSS 493	Temporary Potable Water Supply Services
OPSS 510	Removal
OPSS 517	Dewatering for Excavations
OPSS 539	Temporary Protection Systems

Ontario Provincial Standard Specifications, Material

OPSS 1004	Aggregates - Miscellaneous
OPSS 1301	Cementing Materials
OPSS 1302	Water
OPSS 1350	Concrete - Materials and Production
OPSS 1842	Pressure Polyethylene Pipe Products

CSA Standards

B64.10	Selection and Installation of Backflow Prevention Devices/Manual for the Maintenance and Field Testing of Backflow Prevention Devices
B64.10.01	Selection and Installation of Backflow Preventers/Maintenance and Field Testing of Backflow Preventers [Part of B64 Series-11, Backflow Preventers and Vacuum Breakers Compendium]
B137.1-13	Polyethylene Pipe, Tubing and Fittings for Cold-Water Pressure Services [Part of B137-13, Thermoplastic Pressure Piping Compendium]
B137.2-13	Polyvinyl Chloride (PVC) Injection-Moulded Gasketed Fittings for Pressure Applications [Part of B137-13, Thermoplastic Pressure Piping Compendium]
B137.3-13	Rigid Polyvinyl Chloride (PVC) Pipe and Fittings for Pressure Applications [Part of B137-13, Thermoplastic Pressure Piping Compendium]
B137.3.1-13	Molecularly Oriented Polyvinyl Chloride (PVCO) Pipe and Fittings for Pressure Applications [Part of B137-13, Thermoplastic Pressure Piping Compendium
B137.10-13	Crosslinked Polyethylene/Aluminum/Crosslinked Polyethylene Composite Pressure-Pipe Systems [Part of B137-13, Thermoplastic Pressure Piping Compendium]

ASTM International

A153/A153M-16a	Zinc Coating (Hot Dip) on Iron and Steel Hardware
A276/A276M-17	Stainless Steel Bars and Shapes
A307-21	Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength
B88-20	Seamless Copper Water Tube
B633-19	Electrodeposited Coatings of Zinc on Iron and Steel
B766-86(2015)	Electrodeposited Coatings of Cadmium
C361-19a	Reinforced Concrete Low-Head Pressure Pipe
D3139-19	Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals

American Water Works Association (AWWA)

C104/A21.4-08	Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
C110/A21.10-12	Ductile-Iron and Gray-Iron Fittings for Water
C111/A21.11-17	Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
C151/A21.51-09	Ductile-Iron Pipe, Centrifugally Cast, for Water
C153/A21.53-11	Ductile-Iron Compact Fittings for Water Service
C200-17	Steel Water Pipe - 6 In. (150 mm) and Larger
C205-18	Cement-Mortar Protective Lining and Coating for Steel Water Pipe - 4 in. (100 mm) and Larger
C206-17	Field Welding of Steel Water Pipe
C208-17	Dimensions for Fabricated Steel Water Pipe Fittings
C300-16	Reinforced Concrete Pressure Pipe, Steel-Cylinder Type
C301-14(R19)	Prestressed Concrete Pressure Pipe, Steel-Cylinder Type, for Water and Other Liquids
C302-11	Reinforced Concrete Pressure Pipe, Non-Cylinder Type
C303-17	Concrete Pressure Pipe, Bar-Wrapped, Steel-Cylinder Type
C502-14	Dry-Barrel Fire Hydrants
C504-15	Rubber-Seated Butterfly Valves
C509-15	Resilient-Seated Gate Valves for Water Supply Service
C800-14	Underground Service Line Valves and Fittings
C900-16	Polyvinyl Chloride (PVC) Pressure Pipe, and Fabricated Fittings, 4 in.- 60 in. (100 mm – 1,500 mm), for Water Transmission and Distribution
C907-17	Injection-Molded Polyvinyl Chloride (PVC) Pressure Fittings, 4 in.-12 in. (100 mm - 300 mm), for Water Distribution

C909-16 Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe, 100 mm Through 600 mm (4 in. Through 24 in.), for Water Distribution

American Society of Mechanical Engineers (ASME)

B18.2.1-2012 Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series)

NSF International

NSF/ANSI/CAN 61 Drinking Water System Components - Health Effects

Ministry of Environment, Conservation and Parks (MECP)

Watermain Disinfection Procedure

441.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Associated Appurtenance means structures, devices, and appliances, other than pipe and conduit, which are used in connection with a water distribution system, such as valves, hydrants, corporation cocks, services, and thrust restraints.

Backfilling means the operation of filling a trench with bedding, cover, and backfill material, or embedment and backfill material.

End Covers means temporary cover installed at the factory over both ends of uninstalled watermain pipe to prevent the entry of contaminants during shipping and storage.

Excavation means the excavation of earth and rock as defined in OPSS 206.

Fitting means connections, appliances, and adjuncts designed to be used in connection with pipe: for example, elbows and bends to alter the direction of a pipe; tees and crosses to connect a branch with a main; plugs and caps to close an end; and bushings, diminishers, or reducers to couple two pipes of different diameters.

Service Connection means the system used to supply water from the watermain to the property line.

Service Connection Appurtenance Set means the main stop, curb stop, couplings, service box, service box support, and service saddle used in the installation of a service connection.

Watermain means an installation designed for the conveyance of water under pressure.

441.05 MATERIALS

441.05.01 General

The pipe size, type, and class shall be according as specified in the Contract Documents.

Fittings shall be suitable for and compatible with the pipe material and class with which they are used.

All material for watermains and associated appurtenances shall be NSF/ANSI/CAN 61 compliant.

441.05.02 Ductile Iron Pipe

Ductile iron pipe shall be according to AWWA C151/A21.51.

Fittings shall be gray iron according to AWWA C110/A21.10 or ductile iron according to AWWA C110/A21.10 or AWWA C153/A21.53.

Ductile iron pipe and fittings shall be cement lined according to AWWA C104/A21.4.

Rubber gaskets for push-on or mechanical joints shall be according to AWWA C111/A21.11.

441.05.03 Concrete Pressure Pipe

Concrete cylinder pipe including joints and fittings shall be according to AWWA C300, C301, or C303.

Non-cylinder pipe and joints shall be according to AWWA C302 or ASTM C361. Fittings shall be according to AWWA C302.

441.05.04 Polyvinyl Chloride Pipe

441.05.04.01 General

Flexible elastomeric seals for bell and spigot joints shall be according to ASTM D3139.

Fittings for polyvinyl chloride (PVC) and molecularly oriented polyvinyl chloride (PVCO) pipe shall be either:

a) Gray iron according to AWWA C110/A21.10.

b) Ductile iron according to AWWA C110/A21.10 or AWWA C153/A21.53 and shall be cement lined according to AWWA C104/A21.4.

c) Injection moulded polyvinyl chloride, blue in colour and according to AWWA C907 and CSA B137.2.

d) Prefabricated polyvinyl chloride, blue in colour and according to AWWA C900 and CSA B137.3.

441.05.04.02 Polyvinyl Chloride Pipe (PVC)

Polyvinyl chloride pipe shall be blue in colour, supplied complete with gaskets, and according to AWWA C900 and CSA B137.3.

441.05.04.03 Molecularly Oriented Polyvinyl Chloride Pipe (PVCO)

Molecularly oriented polyvinyl chloride pipe shall be blue in colour, supplied complete with gaskets, and according to AWWA C909 and CSA B137.3.1.

441.05.05 Polyethylene Pipe

Polyethylene pressure pipe shall be according to OPSS 1842.

Fittings shall be either:

a) Flanged gray iron according to AWWA C110/A21.10.

b) Flanged ductile iron according to AWWA C110/A21.10 or AWWA C153/A21.53 and shall be cement lined according to AWWA C104/A21.4.

c) Polyethylene according to OPSS 1842.

d) Heat fusion or insert or compression type fittings according to CSA 137.1.

441.05.05.01 Colour Coding

Where specified in the Contract Documents, the pipe shall be manufactured with blue colour stripes indicating potable water.

441.05.06 Steel Pipe

Steel pipe shall be according to AWWA C200. Fittings shall be according to AWWA C208. Steel pipe shall have a cement-mortar protective lining and coating according to AWWA C205.

441.05.07 Copper Pipe

Copper pipe for service connections shall be according to ASTM B88 and shall be type K soft copper.

441.05.08 Composite Pipe

Crosslink polyethylene/aluminum/crosslink polyethylene composite pressure pipe for service connections shall be according to CSA B137.10.

441.05.09 Valves

441.05.09.01 General

All valves shall open by operating in a counterclockwise direction.

Valves shall be designed for a minimum cold water working pressure of 1,035 kPa.

Valve types shall be one of the following:

a) Valves less than 75 mm shall be brass or bronze gate valves.

b) Valves greater than or equal to 75 mm, and less than or equal to 300 mm, shall be cast or ductile iron gate valves.

c) Valves greater than 300 mm up to and including 600 mm shall be gate or butterfly valves, with depth of cover as specified in the Contract Documents.

d) Valves greater than 500 mm shall be butterfly valves.

Fasteners shall be made from material meeting the strength requirements of ASTM A307 with dimensions according to ASME B18.2.1. Bolts, studs, and nuts shall be cadmium plated according to ASTM B766 or zinc coated according to ASTM A153/A153M or ASTM B633. Fasteners for mechanical joints shall be ductile iron according to AWWA C111/A21.11.

441.05.09.02 Service Line Valves

Valves shall be according to AWWA C800. Type, pressure class, and end connections shall be as specified in the Contract Documents.

441.05.09.03 Gate Valves

Gate valves shall be according to AWWA C509.

Stem sealing on non-rising stem valves shall use O-ring type seals that do not require adjustment.

The gate valve end configuration shall be as specified in the Contract Documents.

441.05.09.04 Butterfly Valves

Butterfly valves shall be according to AWWA C504.

Valves shall be short body flanged or mechanical-joint, class 150B.

Valve shafts shall be stainless steel and when they project through the body, shall have seals that do not require adjustment.

A vertical operating nut shall be provided. Valves shall be provided with an external indicator showing valve position by means of a pointer operating through a 90% arc from open to close.

441.05.09.05 Air Release and Air/Vacuum Valves

Air release and air/vacuum valves shall be single acting type.

441.05.10 Hydrants

Hydrants shall be according to AWWA C502. The type shall be as specified in the Contract Documents.

441.05.11 Reduced Pressure Principle Backflow Preventers

Reduced pressure principle backflow preventers shall be according to CSA B64.10 and B64.10.01.

441.05.12 Service Connection Fittings and Appurtenances

Main stops, curb stops, couplings, service boxes, and service saddles shall be as recommended by the manufacturer of the service connection pipe.

441.05.13 Concrete

Concrete for thrust blocks and fitting and appurtenance supports shall be according to OPSS 1350 with a nominal minimum 28-Day compressive strength of 20 MPa.

441.05.14 Mortar

Mortar for joints shall be composed of one part Portland cement and three parts mortar sand, wetted with sufficient water to make the mixture plastic.

The mortar sand shall be according to OPSS 1004, the Portland cement shall be according to OPSS 1301, and the water shall be according to OPSS 1302.

441.05.15 Straps, Tie-Rods, Angles, Nuts, and Bolts

Stainless steel straps, tie-rods, angles, nuts, and bolts used with concrete thrust blocks shall be according to ASTM A276/A276M, Type 316 stainless steel.

441.05.16 Corrosion Protection

Corrosion protection shall be according to OPSS 442.

441.07 CONSTRUCTION

441.07.01 General

The work for the installation of watermains shall include all watermain pipe, bends, tees, fittings, thrust restraints, and the testing of the watermain system.

The interior of all pipe, fittings, and other accessories shall be kept clean and free from undesirable material at all times.

441.07.02 Site Preparation

Site preparation shall be according to OPSS 490.

441.07.03 Removals

Removals shall be according to OPSS 510.

441.07.04 Preservation and Protection of Existing Facilities

Preservation and protection of existing facilities shall be according to OPSS 491.

441.07.05 Protection Against Floatation

Damage to the pipeline due to floatation shall be prevented during construction and until completion of the work.

441.07.06 Cold Weather Work

All work shall be protected from freezing. Pipe and bedding material shall not be placed on frozen ground.

441.07.07 Transporting, Unloading, Storing, and Handling Pipe

All pipe, fittings, and gaskets that are unsound or damaged shall be rejected.

All pipe up to and including 600 mm diameter shall be delivered to the Work Area with end covers and a tamper evident seal on only the bell end. These components shall adhere sufficiently to withstand the stresses caused during shipment.

A waterproof seal is not required on the end covers.

Tamper evident seals shall display the manufacturers name or logo or both. Seals shall straddle the end cover and the pipe. Removal of the cover shall render the tamper evident seal unusable either by breaking the seal or by leaving a message such as "VOID" on the pipe. Tamper evident seals are not required for non-reusable heat shrink plastic covers or foam plugs with punch-out centres.

Pipe delivered to the Work Area with damaged or missing end covers shall be field cleaned to remove all undesirable material along the entire length of the interior of the pipe and the end covers reinstalled.

Manufacturer's recommendations for transporting, unloading, storing, and handling of materials shall be followed.

441.07.08 Excavation

Excavation for the installation of watermains shall be according to OPSS 401.

441.07.09 Support Systems

Support systems shall be according to OPSS 404.

441.07.10 Dewatering

Dewatering shall be according to OPSS 517.

441.07.11 Temporary Protection Systems

The construction of temporary protection systems shall be according to OPSS 539.

When the stability, safety, or function of an existing roadway, railway, watercourse, other works, or proposed works may be impaired due to the method of operation, protection shall be provided. Protection may include sheathing, shoring, and piling when necessary to prevent damage to such works or proposed works.

441.07.12 Temporary Potable Water Supply Services

Temporary potable water supply services shall be according to OPSS 493.

441.07.13 Backfilling and Compacting

Backfilling and compacting shall be according to OPSS 401.

441.07.14 Installation of Pipe

Pipe shall be laid in a dry trench.

Pipe shall be laid within the alignment and grade tolerances as specified in the Contract Documents. The barrel of each pipe shall be in contact with the shaped bed throughout its full length.

When the Owner raises or lowers the invert of a watermain by up to 150 mm, it shall not constitute a Change in the Work and no adjustment shall be made to the payment. When the invert of a watermain is raised or lowered by more than 150 mm, then this shall constitute a Change in the Work for the full extent of the change from the original grade.

Pipe shall be kept clean and dry as work progresses. A removable watertight bulkhead shall be installed at the open end of the last pipe laid whenever work is suspended.

Pipe shall not be laid until the preceding pipe joint has been completed and the pipe carefully embedded and secured in place.

441.07.15 Jointing

441.07.15.01 General

End covers shall be removed immediately prior to jointing. Joint surfaces shall be clean. Pipe ends shall be lubricated with material recommended by the pipe manufacturer.

Manufacturer's instructions for jointing pipe shall be followed.

Joints and all connections shall be made watertight.

All bolts, nuts, couplings, rubber rings, and connecting pieces shall be cleaned thoroughly before installation.

Pipe shall be aligned on centreline to previously laid pipe.

Pipe shall be pulled or pushed only by a hand-operated winch. A backhoe shall not be used for pushing pipe.

Joints shall be prevented from opening after the pipe has been laid.

441.07.15.02 Ductile Iron Pipe

441.07.15.02.01 Mechanical Joints

The gland shall be positioned on the pipe with the lip extension toward the joint. The gasket shall be slipped on the pipe with the thick edge towards the gland. The spigot end shall be pushed to its seat in the bell. The gasket shall be pressed to seat it evenly around the joint.

The gland shall be positioned for bolting and the bolts shall be inserted. All nuts shall be hand tightened.

The nuts shall be tightened half a turn at a time with a calibrated torque wrench. All nuts shall be tightened uniformly to the torque specified in AWWA C111/A21.11.

441.07.15.02.02 Bell and Spigot Joints

The gasket shall be placed in the groove of the bell making certain it is properly seated.

The gasket shall be lubricated.

Pipe to be joined shall be aligned and the spigot shall be carefully entered into the bell until the spigot end just makes contact with the gasket.

The entry of the spigot into the bell shall be completed by hand or by the use of a hand operated winch until the second reference mark is flush with the face of the bell.

441.07.15.03 Concrete Pressure Pipe

441.07.15.03.01 Bell and Spigot Joints

A cotton or burlap diaper shall be placed around the bell end of the pipe already in place.

A rubber gasket shall be placed on the spigot end of the pipe to be laid ensuring that the stretch and volume of the gasket is equalized around the entire circumference of the pipe. The gasket and spigot shall be lubricated prior to the spigot end being inserted home into the bell end.

The pipe shall be aligned and the spigot end shall be inserted into the bell of the pipe already in place.

Steel inserts shall be placed in the joints to prevent the spigot from entering the full depth of the bell. The location of the rubber gasket shall be checked around the entire circumference of the joint. The steel insert shall be removed and the pipe pushed until the spigot enters the full depth of the socket and is retained in position.

Ensure that the diaper is carefully placed around the joint recess. Cement mortar shall be poured around the assembled joint.

441.07.15.04 Polyvinyl Chloride Pressure Pipe - PVC and PVCO

Joints shall be bell and spigot with rubber gaskets. If gaskets are supplied separately, they shall be inserted in the groove of the bell end of the pipe.

The spigot shall be lubricated. The spigot end shall be inserted and pushed into the bell up to but not beyond the depth of the stop reference mark.

441.07.15.05 Polyethylene Pressure Pipe

Polyethylene pipe 100 mm diameter and larger shall be joined by the thermal butt fusion process. Procedures recommended by the pipe manufacturer shall be followed.

Polyethylene pipe 75 mm diameter and smaller shall be joined with heat fusion or insert or compression type fittings that are recommended by the pipe manufacturer and that prevent pull-out and resist creep deformation at full test pressure.

Connections to non-polyethylene fittings and appurtenances 50 mm diameter and larger shall be made with flanged joints according to the manufacturer's recommendations. Bolts shall be tightened to the torque specified by the manufacturer for the size and type of stub end.

441.07.15.06 Steel Pipe

Steel pipe shall be jointed according to AWWA C200. Field welding for joints shall be according to AWWA C206.

441.07.15.07 Service Connection Pipe

Service connection pipe shall be jointed as recommended by the manufacturer.

441.07.16 Cutting of Pipe

Whenever cutting of pipe is required, the pipe shall be cut according to the recommendations of the pipe manufacturer. After cutting the pipe, the interior of the pipe shall be cleaned and the end cover replaced until the pipe is installed.

441.07.17 Change in Line and Grade

441.07.17.01 Ductile Iron Pipe

Fabricated bends shall be provided for changes in line and grade of 11.25° or more.

Deflections of less than 11.25° may be made using a series of pipe joint deflections. The manufacturer's recommendation in deflecting any single pipe joint shall not be exceeded.

441.07.17.02 Concrete Pressure Pipe

Fabricated bends, bevel adaptors, or elbows shall be used for changes in line or grade greater than 5°. Changes in line or grade less than 5° shall be made using a manufactured joint or bevel connection or may be made over several joints. The manufacturer’s joint deflection recommendations shall not be exceeded.

441.07.17.03 Polyvinyl Chloride Pipe - PVC and PVCO

Polyvinyl chloride pipe joints may be deflected but shall not exceed the manufacturer's recommendations. Otherwise, fabricated bends shall be used.

441.07.17.04 Polyethylene Pipe

Use of pipe flexibility may be allowed but shall not exceed the manufacturer's recommendations.

441.07.17.05 Steel Pipe

Fabricated bends shall be used at all changes in line or grade, unless the change can be accomplished without exceeding the manufacturer's recommendation for deflection at pipe joints.

441.07.18 Installation of Valves and Fittings

441.07.18.01 General

The work for the installation of valves and fittings shall include the couplings and valve boxes, when valve boxes are specified in the Contract Documents. Valves and fittings shall be installed in locations as specified in the Contract Documents. Valves and connecting pipe shall be aligned accurately and supported as specified in the Contract Documents. Valves and fittings do not require end covers but shall be field cleaned prior to installation.

441.07.18.02 Air Release and Air/Vacuum Valves

Air release and air/vacuum valves shall be installed at locations specified in the Contract Documents.

Each air release and air/vacuum valve shall be provided with an isolating valve.

441.07.19 Installation of Hydrant Sets

The work for the installation of hydrant sets shall include the placing of hydrants, hydrant isolating valves, hydrant leads, restraining devices, and support devices.

Hydrant sets shall be installed at locations specified in the Contract Documents.

The hydrant shall be plumb with the nozzles parallel to the edge of pavement or curb line and the pumper connection facing the roadway.

441.07.20 Installation of Service Connections

A service connection shall consist of a service connection pipe and a service connection appurtenance set and shall be installed at locations as specified in the Contract Documents.

Service connection pipe shall be installed by pressure tap connection or saddles. Service connections on plastic watermains shall be installed using service saddles or tapped couplings.

Curb stop valve boxes shall be installed vertically and flush with the final grade elevation.

441.07.21 Shutting Down or Charging Mains

At no time shall watermains be shut down or charged or valves operated without permission from the Contract Administrator.

441.07.22 Connections to Existing Watermains

The work of connecting to existing watermains shall include the removal of all plugs, caps, blow offs, and thrust blocks from an existing watermain or fitting, and the installation of the connection.

All connections to existing watermains shall be made under the supervision of the Contract Administrator.

441.07.23 Thrust Restraints

All connections, caps, and bends shall be restrained by concrete blocking and restrained joints or both, as specified in the Contract Documents. Concrete for thrust blocks shall be placed against undisturbed ground. Joints and couplings shall remain free from concrete. Only restrained joint products specifically designed for use with the pipe material shall be used.

441.07.24 Hydrostatic Testing

441.07.24.01 General

Hydrostatic testing shall be conducted under the supervision of the Contract Administrator upon completion of the watermain, including services and backfilling.

A test section shall be either a section between valves or the completed watermain.

Test pressure shall be 1,035 kPa.

The test section shall be filled slowly with water and all air shall be removed from the pipeline. A 24-hour absorption period may be allowed before starting the test. The test section shall be subjected to the specified continuous test pressure for 2 hours.

441.07.24.02 Polyethylene Pipe

The test procedure shall consist of initial expansion and test phases.

During the initial expansion phase, the test section shall be pressurized to the test pressure and sufficient make-up water added each hour for 3 hours to return to test pressure. The test phase begins after the initial expansion phase.

The test phase shall be 2 hours after which a measured amount of make-up water is added to return the test pressure. If the amount of make-up water added does not exceed the value in Table 1, leakage is not indicated.

If the amount of make-up water exceeds the Table 1 value, all leaks shall be located and repaired and the test section shall be retested until a satisfactory result is obtained.

The test duration should not exceed 8 hours. If the pressure test is not completed, the test section shall be de-pressurized and allowed to relax for at least 8 hours before bringing the test section up to pressure again.

441.07.24.03 Other Pipe

A period of 24 hours shall be allowed before starting the test.

The test section shall be subject to the specified continuous test pressure for 2 hours.

The leakage is the amount of water added to the test section to maintain the specified test pressure for the test duration. The measured leakage shall be compared with the allowable leakage as calculated for the test section. The allowable leakage is 0.082 litres per millimetre of pipe diameter per kilometre of pipe for the 2-hour test period.

If the measured leakage exceeds the allowable leakage, all leaks shall be located and repaired and the test section shall be retested until a satisfactory result is obtained.

441.07.25 Flushing and Disinfecting Watermains

Flushing and disinfecting operations shall be according to the MECP Watermain Disinfection Procedure.

441.07.26 Site Restoration

Site restoration shall be according to OPSS 492.

441.07.27 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

All chlorinated water used for testing, flushing, or disinfecting watermains shall be disposed of safely.

The method of disposal of chlorinated water is subject to the approval of the Contract Administrator.

441.09 MEASUREMENT FOR PAYMENT

441.09.01 Actual Measurement

441.09.01.01 Watermains

Measurement of watermains shall be by length in metres along the horizontal centreline of the pipe from the point of connection to a chamber, water treatment plant, or existing watermain to a point vertically above the end of the new watermain.

441.09.01.02 Valves

For measurement purposes, a count shall be made of the number of valves installed, regardless of the type and size.

441.09.01.03 Hydrant Sets

For measurement purposes, a count shall be made of the number of hydrant sets installed, regardless of the type.

441.09.01.04 Service Connection Pipe

Measurement of service connection pipe shall be by length in metres along the horizontal centreline of the pipe from the point of connection at the watermain to a point vertically above the end of the service connection.

441.09.01.05 Service Connection Appurtenance Sets

For measurement purposes, a count shall be made of the number of service connection appurtenance sets installed.

441.09.01.06 Connections to Existing Watermains

For measurement purposes, a count shall be made of the number of connections made to existing watermains.

441.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

441.10 BASIS OF PAYMENT

441.10.01 Watermains - Item
Valves - Item
Hydrant Sets - Item
Service Connection Pipe - Item
Service Connection Appurtenance Sets - Item
Connections to Existing Watermains - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

TABLE 1
Test Phase Make-Up Amount for Pressure Polyethylene Pipe

Pipe Diameter mm	Make-Up Water litre/km
30	12.38
40	12.38
50	13.62
75	18.60
100	31.00
150	74.50
200	124.20
250	161.40
275	248.30
300	285.60
350	335.20
400	409.70
450	533.90
500	682.90
550	869.10
600	1,105.00
700	1,378.20
800	1,775.50
900	2,234.90
1,000	2,731.60
1,050	3,104.00
1,200	3,973.20
1,350	5,152.70
1,600	7,449.70

Appendix 441-A, Commentary for OPSS.MUNI 441, November 2021
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer may consider including soil boring data, a geotechnical report, a subsurface report, or a soils report in the Tender Documents.

The designer should include the following in the Contract Documents:

- Pipe size, type, and class. (441.05.01)

- Colour coding. (441.05.05.01)

- Gate valves can be considered as long as sufficient depth of cover is available. (441.05.09.01)

- Service line valve type, pressure class, and end connections. (441.05.09.02)

- Gate valve end configuration. (441.05.09.03)

- Type of hydrants. (441.05.10)

- Alignment and grade tolerances for the pipe installation. (441.07.14)

- Valve type and location. (441.07.18.01)

- Air release and air/vacuum valve locations. (441.07.18.02)

- Location of hydrant sets. (441.07.19)

- Location and size of service connections. (441.07.20)

- Thrust restraints. (441.07.23)

- The designer should determine if valve boxes are needed and, if so, they should be specified in the Contract Documents. (441.07.18.01)

- Air release and air/vacuum valves. (441.07.18.02)

- Installation of hydrant set. (441.07.19)

- Installation of service connections. (441.07.20)

- Thrust restraints. (441.07.23)

Tracer wire or tracer tape should be specified, if appropriate.

Under conditions of high ground water, external fluids may enter via air release and air/vacuum release valves; therefore, appropriate measures should be taken.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 1101.012	Precast Concrete Valve Chamber with Poured-In-Place Thrust Blocks, 1800 x 2400 mm, Components
OPSD 1101.013	Precast Concrete Valve Chamber with Poured-In-Place Thrust Blocks, 1800 x 2400 mm, Riser and Base
OPSD 1101.014	Precast Concrete Valve Chamber with Poured-In-Place Thrust Blocks, 1800 x 2400 mm, Thrust Blocks
OPSD 1101.015	Precast Concrete Valve Chamber with Poured-In-Place Thrust Blocks, 1800 x 2400 mm, Chimney and Cap
OPSD 1101.016	Precast Concrete Valve Chamber with Poured-In-Place Thrust Blocks, 2400 x 3000 mm, Components
OPSD 1101.017	Precast Concrete Valve Chamber with Poured-In-Place Thrust Blocks, 2400 x 3000 mm, Riser and Base
OPSD 1101.018	Precast Concrete Valve Chamber with Poured-In-Place Thrust Blocks, 2400 x 3000 mm, Thrust Blocks
OPSD 1101.019	Precast Concrete Valve Chamber with Poured-In-Place Thrust Blocks, 2400 x 3000 mm, Chimney and Cap
OPSD 1101.020	Valve Operator
OPSD 1101.030	Precast Concrete Valve Chamber With Poured-in-Place Thrust Blocks, 3000 x 3000 mm Components
OPSD 1101.031	Precast Concrete Valve Chamber With Poured-in-Place Thrust Blocks, 3000 x 3000 mm Riser and Base
OPSD 1101.032	Precast Concrete Valve Chamber With Poured-in-Place Thrust Blocks, 3000 x 3000 mm Thrust Blocks
OPSD 1101.033	Precast Concrete Valve Chamber With Poured-in-Place Thrust Blocks, 3000 x 3000 mm Chimney and Cap
OPSD 1101.040	Precast Concrete Valve Chamber With Poured-in-Place Thrust Blocks, 3600 x 3000 mm Components
OPSD 1101.041	Precast Concrete Valve Chamber With Poured-in-Place Thrust Blocks, 3600 x 3000 mm Riser and Base
OPSD 1101.042	Precast Concrete Valve Chamber With Poured-in-Place Thrust Blocks, 3600 x 3000 mm Thrust Blocks
OPSD 1101.043	Precast Concrete Valve Chamber With Poured-in-Place Thrust Blocks, 3600 x 3000 mm Chimney and Cap
OPSD 1103.010	Concrete Thrust Blocks for Tees, Plugs, and Horizontal Bends
OPSD 1103.020	Concrete Thrust Blocks for Vertical Bends
OPSD 1104.010	Water Service Connection, 19 and 25 mm Diameter Sizes
OPSD 1104.020	Water Service Connection, 32, 38, and 50 mm Diameter Sizes
OPSD 1104.030	25 mm Blow Off Installation
OPSD 1105.010	Hydrant Installation
OPSD 1107.010	Piping Layout for Water Meters 50 mm and Smaller in Chambers
OPSD 1107.020	Piping Layout for Water Meters 75 to 250 mm in Chambers with By-Pass
OPSD 1107.030	Piping Layout for Water Meters in Building with By-Pass
OPSD 1108.010	Cast-In-Place Water Meter Chamber for 75 to 250 mm Meters
OPSD 1109.010	Cathodic Protection for Metallic Watermain Systems
OPSD 1109.011	Cathodic Protection for PVC Watermain Systems
OPSD 1109.012	Cathodic Protection off Existing Metallic Watermains, Exposed Service or Pipe Method
OPSD 1109.013	Anode Installation Over Pipe Method for Existing Metallic Watermains
OPSD 1109.014	Horizontal Anode Bank at Service
OPSD 1109.015	Vertical Anode Bank at Service
OPSD 1109.025	Waterproofing of Splices

CONSTRUCTION SPECIFICATION FOR CORROSION PROTECTION OF NEW AND EXISTING WATERMAINS

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442-A **Commentary**

442.01 SCOPE

This specification covers the requirements for providing corrosion protection to watermains and their metallic components, valves and fittings using galvanic anodes, or a microcrystalline wax and petrolatum tape coating system.

This specification also covers the requirements for corrosion monitoring for concrete pressure pipe.

442.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be as specified in the Contract Documents.

442.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

442.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 441	Watermain Installation in Open Cut
OPSS 490	Site Preparation for Pipelines, Utilities, and Associated Structures
OPSS 492	Site Restoration Following Installation of Pipelines, Utilities, and Associated Structures

CSA Standards

C22.2 No. 197:M1983 (R2018) PVC Insulating Tape

ASTM International

B418-16a	Cast and Wrought Galvanic Zinc Anodes
B843-18e1	Magnesium Alloy Anodes for Cathodic Protection
G97-18	Standard Test Method for Laboratory Evaluation of Magnesium Sacrificial Anode Test Specimens for Underground Applications

American Water Works Association (AWWA)

C217-16	Microcrystalline Wax and Petrolatum Tape Coating Systems for Steel Water Pipe and Fittings

Underwriters Laboratories of Canada (ULC)

UL 467-13	Grounding and Bonding Equipment

442.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Anode means the electrode of an electrochemical cell where corrosion occurs and metal ions enter solution. An anode refers to a packaged anode consisting of the casting, chemical packing material, lead wire, tube, and label.

Anode Chemical Packing means select materials used to surround an anode in its tube in order to improve current efficiency, reduce local corrosion of the anode casting, help keep the anode moist, and increase the effective anode size and, for zinc, prevent the passivation of the anode.

Anode Type means both the material and the size of the anode shown in Table 1, which is included in the A-WW-LL label on the outside of the anode. The A location indicates the casting alloy material, Z for zinc and M for magnesium. The WW indicates the weight of the casting in pounds and the LL indicates the length of the casting in inches.

Associated Appurtenances means structures, devices, and appliances, other than pipe and conduit that are used in connection with a water distribution system, such as valves, hydrants, saddles, corporation and main stops, curb stops, services, and thrust restraints.

Backfill means material placed in a hole to fill the space around the anodes and other portions of the project.

Bonding means the joining of metallic components together to ensure complete electrical continuity throughout the piping system.

Cathodic Protection means a technique to control the corrosion of a metal surface by making that surface the cathode of an electrochemical cell.

Certified Cathodic Protection Specialist means a person that has received Cathodic Protection Specialist Certification by NACE International.

Coating means a dielectric material applied to a structure to separate it from the environment.

Corrosion Protection means corrosion control of a metal surface either by coatings or cathodic protection or both.

Filler means a microcrystalline wax or petrolatum-based material used to fill voids or surface irregularities where the tape will not be in full contact with the steel surface. Also referred to as a mastic.

Fittings means as defined in OPSS 441.

Galvanic Anode means a metal that provides protection to metals that are more noble in the galvanic series when coupled in an electrolyte. This is in contrast to impressed current anode systems that use an external direct current power source between the cathode and anode bed.

Ground Clamp means a copper clamp device used to connect a wire to copper service tubing in order to create an electrical connection to earth.

Holiday means a discontinuity in the coating.

Metallic Components means metallic hydrants, valves, fittings and associated appurtenances designed to be used in connection with pipes.

Metallic Watermain or Pipe means a ductile iron, cast iron, or steel watermain pipe, excluding copper services.

Microcrystalline Wax means a refined mixture of solid, saturated aliphatic hydrocarbons produced by de-oiling petrolatum.

Negative Lead means the wire running from the watermain or service pipe to the test station.

Petrolatum means a complex semisolid mixture of microcrystalline wax and white mineral oil distilled from petroleum wax.

Primer means a compound of microcrystalline wax or petrolatum and may contain suitable inhibitors.

Tape means a cold-applied saturant tape made from either microcrystalline wax or petrolatum and a noncellulosic synthetic fiber fabric.

Tape Coating System means the complete finished corrosion protection product consisting of the primer, filler, if applicable, and tape.

Test Station means a pole or flush mounted terminal that is used to conveniently monitor electrical currents and potentials associated with galvanic cathodic protection systems.

Thermite Weld means a permanent low resistance electrical connection made by a powder welding process using an exothermic copper-depositing mixture ignited in a graphite mould.

Valves means as defined in OPSS 441.

Watermains means as defined in OPSS 441.

442.05 MATERIALS

442.05.01 Zinc and Magnesium Anodes

442.05.01.01 Zinc Anode Castings

Zinc anode castings shall have a high potential alloy composition according to ASTM B418, Type II.

442.05.01.02 Magnesium Anode Castings

Magnesium anode castings shall have a composition according to ASTM B843, Type M1-C, and have a minimum current efficiency of 50% and shall be according to ASTM G97.

442.05.01.03 Steel Core of Anode Castings

The steel core of the anode castings shall be electro-galvanized and extend a minimum 75% of the anode length.

442.05.02 Anode Packaging

The magnesium and zinc anode castings shall be supplied complete with an anode lead wire and shall be centred in and surrounded by chemical packing material. The anode casting and chemical packing shall be contained within a biodegradable, water permeable cardboard tube of sufficient durability to permit normal handling without appreciable damage. Anode castings and overall weight requirements shall meet the requirements specified in Table 1. However, the length dimensions and overall package requirements may be used as a guide to account for the fact that each manufacturer's products may vary slightly from the values noted in Table 1.

442.05.02.01 Anode Chemical Packing Composition

The chemical packing material shall have an electrical resistivity of less than 45 ohm-cm when saturated with distilled water, a compacted density of 1.5 g/cm^3, and the following composition:

Chemical Packing Component	% by Volume
Gypsum	77 ± 2%
Bentonite	15 ± 1%
Sodium Sulphate	8 ± 1%

442.05.02.02 Labelling

All anodes shall be labelled on the outside of the cardboard tube indicating the type and the specification designation OPSS 442, as follows:

a) For each zinc anode, each tube shall be labelled as follows:

A-WW-LL Anode According to OPSS 442 (e.g., Z-6-12 Anode According to OPSS 442)

b) For each magnesium anode, each tube shall be labelled as follows:

A-WW-LL Anode According to OPSS 442 (e.g., M-17-20 Anode According to OPSS 442)

The letters shall be a minimum of 25 mm in height.

442.05.03 Microcrystalline Wax and Petrolatum Tape Coating Systems

Microcrystalline Wax and Petrolatum tape coating system components shall meet the material and testing requirements of AWWA C217.

442.05.03.01 Labeling

All components of a tape coating system including the primer, mastic and petrolatum or petroleum wax tape shall be properly labeled on the outside of the package as to the contents and name of the manufacturer.

442.05.04 Wires

Bond wires shall be 450 mm in length with TWU or RWU-90 black insulation with AWG #4/7 strand copper wire or, when specified, AWG #1/0 - 19 strand copper wire.

Anode wires shall be 3.0 m in length of AWG #10/7 strand copper wire having RWU-90 insulation, blue for magnesium anodes, and white for zinc anodes, and shall be silver soldered to the steel core of the anode casting.

Anode header wires for anode banks shall be AWG #10/7 strand wire with red RWU-90 insulation.

Negative wires from test stations to ground clamps or pipe shall be AWG #10/7 strand wire with RWU-90 black insulation.

Wire for corrosion monitoring probes for concrete pressure pipe shall be AWG #10/7 strand wire with RWU-90 black insulation.

Wire for connecting the watermain negative wires from the pipe joint bonding wire of concrete pressure pipe to the test station shall be AWG #4/7 strand wire with RWU-90 black insulation.

442.05.05 Test Stations

Each test station shall consist of a non-conductive housing and lid and shall be either flush-mounted or post-mounted as specified in the Contract Documents. The lid shall be supplied with a stainless steel locking bolt and an Allen key head and shall be blue in colour. The terminal board shall include 5 stainless steel terminals and one nickel plated copper bonding or shorting strap. All terminals shall have two stainless steel nuts for locking purposes.

a) Flush-mounted test stations shall be mounted on a 300 mm length of 150 mm diameter UV stabilized polyethylene or polycarbonate pipe.

b) Post-mounted test stations shall be mounted on a 1,500 mm length of 32 mm diameter PVC or UV stabilized polyethylene pipe and fastened securely to a suitable support.

442.05.06 Thermite Welds

The thermite weld material shall be as follows:

Thermite Moulds or Welders:

a) Shall be suitable for the wire, connection type, and orientation.

b) Shall have a handle and lid.

c) Shall be made of graphite or synthetic graphite, be able to withstand high temperatures, and be designed to provide an average life of not less than 50 separate exothermic welds.

d) Shall be from the same manufacturer as the weld metal.

Thermite Powder Cartridges:

a) Shall be suitable for the pipe material.

b) Weld metal shall contain vanadium, but not tin.

c) Weld metal shall be sealed in a suitable capsule and be identified with the part number and size and type of metals to be connected, such as copper to steel or copper to ductile iron.

d) The batch control numbers shall be packaged with the product prior to shipment from the factory.

Starting Material:

a) When used, shall consist of aluminum, copper, and iron oxide materials. It shall not contain phosphorous or any caustic, toxic, or explosive substances.

b) When used, shall be electrical igniters that have a lead length of 1.83 m or greater and use an electric ignition system that does not use spark ignition material.

Thermite Weld Protective Barrier Covers:

a) Shall be moulded plastic domes filled with corrosion resistant compound on a base of thick elastomeric tape.

b) Shall use an integrated primer in its adhesive.

Thermite Weld Protective Barrier Coatings:

a) Shall bond firmly to surfaces without the use of primers and form a tough coating resistant to oxidizing, cracking, alligatoring, checking, loosening, or scaling.

b) Shall be composed of heavy mastic with synthetic elastomeric additives in mixed solvent.

442.05.07 Miscellaneous Materials

Ground clamps for copper water services shall be UL 467 listed for direct burial, high strength, high conductivity, and a minimum of 80% copper alloy.

Direct Bury Lugs:

a) Shall be one piece, high impact housing, pre-filled with silicone providing waterproof and corrosion proof protection and be designed for long term direct bury applications.

b) Shall be able to connect to header wire without cutting the header wire.

c) Shall tighten with a screwdriver.

d) Shall have high impact housing without sharp edges to prevent cuts or handling discomfort.

e) Shall be designed for use with wires from #14 to #10 AWG or larger and under 50 volts.

Wire splicing kits for cathodic protection systems shall be waterproof and suitable for direct bury applications.

C Taps shall be as specified in the Contract Documents.

The solder shall be 60% tin and 40% lead mix, resin core type.

Moisture proofing shall be fast drying sealant and bonding compound specifically designed for coating electrical connections.

Insulating putty shall be dielectric, easy to handle and apply, have excellent adhesion to surfaces, and be suitable for filling voids and irregular surfaces.

Self-amalgamating tape shall be made using modified silicone rubber compound that forms a moisture-proof abrasion-resistant bond. Tape shall have high dielectric strength, adhering to itself creating an immediate permanent bond even when wet.

Rubber splicing tape shall be 25 mm wide waterproof neoprene.

Electrical tape shall be 25 mm wide PVC electrical tape, rated for 600 V with a working temperature of -10 to 90 °C, and according to CSA C22.2 No. 197.

442.07 CONSTRUCTION

442.07.01 General

The methods for corrosion protection shall be as specified in the Contract Documents.

Anodes shall be installed complete with their cardboard tube container and enclosed chemical packing.

The anode shall be wetted prior to backfill, to enhance performance.

442.07.02 Site Preparation

Site preparation shall be according to OPSS 490.

442.07.03 Transporting, Unloading, Storage, and Handling Materials

Anodes and other materials that can be damaged by exposure to the elements shall be stored in a clean dry secured enclosure until installation.

Anodes shall not be carried or lowered by their lead wires.

All components of a tape coating system shall be transported, stored and handled according to manufacturer's recommendations.

442.07.04 Anode Installation

442.07.04.01 Existing Metallic Watermains - Over Pipe Method

Prior to installation, the location for each anode and test station shall be marked with a white stake or white paint on paved areas and shall be approved by the Contract Administrator.

Anodes shall be of the type and spacing specified in Table 2. The first anode at each end of the watermain shall be within 3.0 m of the end of the watermain.

Anode locations may be shifted a maximum of 3.0 m to avoid driveways and other paved areas.

Each anode site shall be excavated to expose the top of the pipe and accommodate the anode to be installed.

The anode wire shall be thermite welded to the metallic pipe and the connection protected.

The excavation shall be partially backfilled with native backfill so that the anode shall reside 300 mm above the watermain.

The excavation shall be backfilled with material matching the existing subgrade that shall be manually compacted and thoroughly watered. Granular subbase and base profiles shall be reinstated above the subgrade.

442.07.04.02 Existing Metallic Watermains - Anode Bank Method

The anode bank method applies to both vertical and horizontal anode banks for the purpose of retrofitting existing metallic watermains with cathodic protection.

Anodes and anode banks shall be of the type and spacing specified in Table 3.

Anode banks shall be installed on the side of the street opposite to the watermain. Anodes shall be installed so the centre of the anode is at the same depth as the service to which they are being attached or a minimum of 2.0 m below the finished grade, whichever is greater.

Each anode site shall be excavated to expose the top of the pipe and accommodate the anode to be installed.

The anode leads shall be spliced to the header wires using one of the approved wire splicing methods.

442.07.04.03 Existing Metallic Watermains - Exposed Pipe or Service Method

The exposed pipe or service method applies when an existing watermain is not catholically protected, and

when the existing watermain or water services are exposed during the course of other work (e.g., another Utility installation or watermain break repair).

Anodes to be used for this application shall be magnesium type M-32-22.

Anodes shall be installed at least 1.5 m horizontally away from the watermain pipe and as deep as the bottom of the excavation. Anodes shall be spaced as far apart in the trench as the wires and trench permit.

The anode lead shall be electrically connected to the water piping by connecting to either:

a) A copper or lead service pipe using a ground clamp.

b) The watermain using the thermite weld procedure.

442.07.04.04 New Metallic Watermains and Copper Services

Anodes shall be of the type and spacing specified in Table 4.

Anodes shall also be installed as follows:

a) On the lateral piping of each hydrant.

b) At each metallic component.

Anodes shall be installed at least 1.0 m horizontally away from the watermain or service pipes and as deep as the bottom of the pipes. The minimum distance between anodes shall be 1.0 m.

442.07.04.05 New Polyvinyl Chloride Watermains with Metallic Components

Anodes shall be of the type and spacing specified in Table 5.

Anodes shall be installed at least 1.0 m horizontally away from the metallic component and as deep as the bottom of the metallic component. The minimum distance between anodes shall be 1.0 m.

442.07.04.06 New Watermains with Metallic Components

All metallic components specified in the Contract Documents shall be protected using corrosion protection methods as specified in the Contract Documents.

442.07.05 Corrosion Monitoring for Concrete Pressure Pipe

The locations for corrosion monitoring test stations shall be as specified in the Contract Documents.

All concrete watermains shall include bonding wires connected by thermite weld to provide electrical continuity. Galvanic zinc anodes are recommended.

All concrete pressure pipe sections, including pipe within jacking and boring encasement pipe and all bevel and bend fittings shall have two electrical bonding connections on each side, located 45° off the vertical.

Corrosion test monitoring stations for concrete pressure pipe shall include three probes or pipe coupons at each station. The probes shall be connected to the test monitoring station with approved wire.

442.07.06 Tape Coating System Installation

442.07.06.01 General Surface Preparation Requirements

Remove mud, loose mill scale, lacquer, wax, paint, coal tar, asphalt, oil, grease, excessive surface moisture and other foreign matter from the bare metallic surface. Surfaces shall be inspected and, if required, precleaned according to SSPC-SP 1.

Remove weld slag, spatter and scale, sharp points, burrs and edges.

Bare metal surfaces to be coated shall be cleaned immediately before applying the tape coating system.

High pressure water blasting may be used to prepare the surface of an existing metallic pipe, valve or fitting. An Engineer shall determine the appropriate pressure to provide adequate cleaning of the surface to apply the product, and any necessary precautions that must be taken during the water blasting process.

Ensure that any new metal valves, fittings and fasteners are clean and free from any mud, grease and oil, or other foreign matter prior to installation of a tape coating system.

Refer to the latest version of AWWA C217 for further details.

442.07.06.02 Watermains, Valves and Fittings

Apply specified primer by brush, hand, glove, or roller. Apply a uniform and continuous film over the entire surface to be wrapped. Apply a liberal coating to threads, cavities, shoulders, pits, etc.

To protect irregular surfaces and sharp edges such as valve bodies, flanges, couplings, fasteners, etc., apply the filler (profiling mastic) by filling spaces and packing into or around irregular surfaces to achieve a uniform contour to which tape can be applied without bridging or voids.

Refer to the manufacturer’s specification for application of tape around straight line pipe.

Refer to the manufacturer’s specification for application of tape on valve bodies, flanges, and couplings.

442.07.07 Test Station Installation - General

Test stations shall be installed at locations as follows:

a) Where they do not interfere with or present a hazard to pedestrian or vehicular traffic and at the nearest property line, whenever possible.

b) For new metallic watermains, over pipe method, and concrete pressure pipe, at each hydrant and, if there are no hydrants, start within 20 m of the project limit and locate at 150 m intervals along the watermain.

c) At each anode bank.

Flush-mounted test stations shall be installed flush with the ground, sidewalk, or pavement surface. Post-mounted test stations shall be mounted so that the top of the cover is 600 mm above the surface.

The anode lead may be extended using an additional length of the same type of wire spliced with an approved splice connection method.

Except for corrosion monitoring applications, test station connections shall be as follows:

a) The two negative leads shall be brought into the test station and connected to terminals 2 and 3.

b) Terminal 1 shall be connected to Terminal with a bonding strap.

c) No bonding strap shall be connected to terminal 3 or 4.

Sufficient wire slack of 0.5 m in the housing below the panel shall be left in the wires to prevent any stress on either during backfilling and subsequent soil settlement and for withdrawing the terminal panel, if necessary during test work.

442.07.07.01 Test Station Connections for New Metallic Watermains

The lead wire of the anode nearest to the test station shall not be welded directly to the pipe, but instead shall be brought into the test station and connected to terminal 1.

Two watermain negative wires shall be thermite welded to the crown of the watermain pipe 150 mm apart and the other ends of the wires shall be connected according to the Test Station Installation - General subsection.

442.07.07.02 Test Station Connections for Anode Banks

The header wires shall be brought into the test station and connected to terminal 1.

Two watermain negative wires shall be attached to the metallic service line, each with their own ground clamp and the other ends of the wires shall be connected according to the Test Station Installation - General subsection.

442.07.07.03 Test Station Connections for Corrosion Monitoring

Two watermain negative wires shall be connected to the concrete pressure pipe joint bonding wires with an approved splice connection method. The other ends of the wires shall be connected to terminals 1 and 2 of the test station. The three probe or pipe coupon wires shall be brought into the test station and connected to terminals 3, 4, and 5.

442.07.08 Thermite Weld Connections

All wire connections to metallic surfaces shall be made by means of a thermite weld method according to the following procedure:

a) Remove all coating, and clean bright and thoroughly dry a 75 mm^2 metal welding surface .

b) Select the proper mould for the application.

c) Insert bared end of wire into mould. A reinforcing sleeve may be required, depending on flexibility of wire. Manufacturer’s instructions shall be followed.

d) Thermite weld the anode lead to the metallic surface shall be according to the manufacturer’s instructions.

e) Remove all slag from the weld-on wire connection and file smooth all sharp edges.

f) The integrity of each weld shall be tested by giving a sharp pull on the lead wire.

Sufficient slack shall be left in the wires to prevent any stress on either the anode or the wire-to-pipe connection during backfilling and subsequent soil settlement.

For new watermains, and where practical for existing watermains, the anode lead wire shall be wrapped around the pipe and secured with a knot. The free end of the wire shall then be thermite welded to the watermain, metallic component, or valve.

442.07.09 Thermite Weld Protection

The cleaned metallic surfaces, thermite weld, and the exposed copper wire surfaces shall all be protected with an approved thermite weld protective barrier coating or cover. Both shall overlap existing coating and insulation on wire to prevent holidays in the protection.

Coating and cover shall be installed according to the manufacturer's instructions.

442.07.10 Anode and Header Wire Splicing and Waterproofing

Wire splicing to the header wire shall be accomplished without cutting the header wire.

Wire to wire splicing shall be accomplished by one of the following methods as specified in the Contract Documents:

a) Approved C Taps.

b) Approved direct bury lugs with built-in waterproof protection.

c) Soldered splices.

d) Wire-to-wire thermite weld.

Splicing products shall be suitable for the size of wire being spliced.

Prior to backfilling, all splices and connections without built-in waterproof protection shall be rendered waterproof by either careful application of the waterproof tape method or by use of a wire splicing kit designed for cathodic protection.

Waterproof tape method shall be performed as follows:

a) Apply moisture proofing over connector and exposed wire.

b) Apply insulating putty to break sharp corners at the connection.

c) Apply tape according to one of the following methods:

   i. Two half-lapped layers of approved self-amalgamating tape overlapping the wire insulation.
   ii. Four half-lapped layers of approved rubber splicing tape overlapping the wire insulation and apply four half-lapped layers of approved self-adhesive electrical tape.

When using splicing kits designed for cathodic protection systems, the kits shall be applied according to the manufacturer's instructions.

442.07.10.01 C Tap Splices

Prior to cutting the wire for splicing, the wire shall be loose to avoid stretching.

The wire shall be stripped about the length of the electrical connector using an appropriate stripping tool. The exposed copper wire shall be free of nicks or scores.

An approved C Tap shall then be placed over the exposed area of the wire. The connecting wire shall be carefully inserted into the C Tap up to the insulation and tightened using an approved compression tool specifically designed for C Taps. Vice-grips, pliers, battering with a hammer, etc. shall not be permitted.

The splice shall be inspected for exposed copper and snugness. Splices that fail inspection shall be cut and redone.

442.07.10.02 Direct Bury Lug Splices

Splices using direct bury lugs shall be performed according to the manufacturer's instructions.

442.07.10.03 Soldered Splices

Soldered connections shall be performed according to industry practices.

442.07.11 Electrical Bonding of Joints

442.07.11.01 New Metallic Pipe

All new metallic pipe joints, valves, and components shall be connected together with a bond wire to ensure complete electrical continuity throughout the metallic piping system. Bond wires shall be connected to the metallic surfaces using a thermite weld.

Bare copper bond straps, conductivity screws, and conductivity wedges shall not be used to provide electrical continuity. If bare copper bond straps are supplied with the piping, they shall be removed.

442.07.11.02 Existing Metallic Pipe

Bond wires shall be installed by thermite welding between all metallic components and across all joints that are exposed within the excavation.

Where a repair clamp is installed across a break, a bond wire shall be installed across the break after repair clamp installation.

Where a cut-out is required, a bond wire shall be installed.

442.07.12 Wire Connections to Copper Services

The anode lead shall be connected to copper services using a ground clamp. Ground clamps shall be attached to copper services according to the manufacturer's instructions. Wires shall be connected to the ground clamps according to the manufacturer's instructions.

442.07.13 Anode Backfilling

In all cases, the anode shall be placed in native soil, not in granular bedding material. The Contract Administrator shall inspect the anode installation prior to backfilling. Backfill shall be packed uniformly around the anode container to eliminate voids adjacent to the anode.

442.07.14 Testing and Evaluation

For applications using test stations, the following procedures shall be performed and recorded between 90 and 120 Days after the installation:

a) Pipe potentials shall be measured with respect to a copper sulfate electrode at maximum intervals of 30 m throughout the route of the piping. The voltmeter employed to measure these potentials shall have an input impedance not less than 10 mega Ohms.

b) Potential measurement connection locations shall be made at the nearest test station to the electrode. The reference electrode and pipe connection locations employed for the potential measurements shall be identical for both the pre-construction and post-construction testing procedures. The electrical continuity of the piping shall be verified by comparison of pipe potential.

c) During post construction testing, the following measurements shall be made at the test stations:

   i. Anode output current.
   ii. Pipe potential with anode connected.
   iii. Pipe potential with anode disconnected.

All testing data and associated recommendations pertinent to the continued effectiveness of the cathodic protection system shall be included in a comprehensive written report. This report shall be prepared by an Engineer or a Certified Cathodic Protection Specialist, and shall be submitted to the Contract Administrator.

442.07.15 Site Restoration

Site restoration shall be according to OPSS 492.

442.07.16 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

442.08 QUALITY ASSURANCE

442.08.01 Anodes

Prior to installing each shipment of anodes, a copy of a certificate shall be forwarded to the Owner from the anode manufacturer indicating that the shipment of anodes complies with the requirements of this specification.

The Owner may randomly select samples of supplied anodes for testing by an independent laboratory.

Any batch of anodes found not to be according to this specification shall be replaced immediately. No additional work shall take place until such time that the anodes are approved and accepted by the Owner.

Any installed anodes found not to be according to the required specifications shall be replaced.

442.08.02 Tape Coating Systems

Ensure that the complete tape coating system supplied is according to this specification.

Prior to installing any tape coating system, confirm to the Owner that the tape coating system supplied complies with the requirements of this specification.

Any installed tape coating system found not to be according to this specification shall be removed and replaced.

442.09 MEASUREMENT FOR PAYMENT

442.09.01 Actual Measurement

442.09.01.01 Individual Anodes

For measurement purposes, a count shall be made of the number of each anode type installed, other than in an anode bank, and of the number of anodes supplied for testing.

442.09.01.02 Anode Banks

For measurement purposes, a count shall be made of the number of each anode bank type installed.

442.09.01.03 Test Stations

For measurement purposes, a count shall be made of the number of each test station type installed.

442.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

442.10 BASIS OF PAYMENT

442.10.01 ***"type"*** **Individual Anode - Item**
"type" **Anode Bank - Item**
"type" **Test Station - Item**

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

When an existing unprotected watermain or service is exposed during the construction of other work, payment for the labour, Equipment, and Material for such work shall be full compensation for the excavation, backfill, and compaction required to install anodes on the exposed watermain or service.

Replacement of anodes that do not meet the requirements of this specification shall be at no extra cost to the Owner.

442.10.02 Tape Coating Systems

Payment for the supply and installation of a tape coating system shall be according to requirements of the Construction Contract.

Replacement of any tape coating system that does not meet the requirements of this specification shall be the Contractor’s responsibility at no extra cost to the Owner.

TABLE 1
Casting Weights and Approximate Finished Product Package Weights and Dimensions

Anode Type	Casting				Finished Product Overall Package			
	Nominal Weight		Approximate Length Range *		Approximate Weight Range *		Approximate Dimensions Range *	
			From	to			Diameter	Length
	Lbs	Kg	mm	mm	Lbs	Kg	mm	mm
Zinc								
Z-5	5	2.3	175	250	14-17	6.4 - 7.7	100 - 130	400 - 510
Z-6	6	2.7	275	375	14-17	6.4 - 7.7	100 - 130	400 - 510
Z-12	12	5.4	575	625	26-28	11.8 - 12.7	100 - 130	675 - 760
Z-24	24	10.9	550	1220	50-55	22.7 - 25	100 - 130	1000 - 1520
Magnesium								
M-5	5	2.3	175	200	12-17	5.5 - 7.7	127 - 160	250 - 430
M-9	6	4.0	325	550	20-30	9.1 - 13.6	127 - 160	425-600
M-17	17	7.7	575	650	35-50	15.9-22.7	127 - 160	750 - 800
M-32	32	14.5	475	600	80-90	36.4 - 40.9	200 - 225	725-775

* Call manufacturer for exact weights and dimensions

TABLE 2
Anode Spacing for Over Pipe Method

Pipe Diameter mm	Anode Type	Spacing m
100	M-32-22	22.0
150	M-32-22	15.0
200	M-32-22	11.5
250	M-32-22	10.0
300	M-32-22	8.0
400	M-32-22	6.0
600	M-32-22	4.5

TABLE 3
Anodes Per Location for the Horizontal and Vertical Anode Bank Method

Pipe Diameter mm	Anode Type	Number of Anodes Per Location	Spacing m
150	M-32-22	8	70 ± 5
200	M-32-22	10	70 ± 5
250	M-32-22	12	70 ± 5
300	M-32-22	14	70 ± 5

TABLE 4
Anode Spacing for Metallic Pipe and Copper Services

Diameter mm	Anode Size	Maximum Spacing m
Less than 50 mm Copper Service	Z-12-24	20.0
50 mm Copper Service	Z-12-24	16.0
100	Z-24-48	12.0
150	Z-24-48	8.0
200	Z-24-48	6.0
250	Z-24-48	5.0
300	Z-24-48	4.0
400	Z-24-48	3.0

TABLE 5
Anode Locations and Spacing for New PVC Pipe with Metallic Components

Location	Anode Type	Maximum Spacing and Quantity
Less than 50 mm Copper Service	Z-12-24	20.0 m
50 mm Copper Service	Z-12-24	16.0 m
100 - 300 mm Metallic Fittings and Valves	Z-12-24	1 per fitting and valve
400 mm Metallic Fittings and Valves	Z-24-48	1 per fitting and valve
Hydrant Bases	Z-24-48	1 per hydrant
Tracer Wire	Z-12-24	1 per every 1,000 m of tracer wire

Appendix 442-A, November 2020
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- The test station to be flush-mounted or post-mounted. (442.05.05)

- Length of post-mounted test stations (442.05.05)

- Type of C Taps. (442.05.07)

- General methods of corrosion protection. (442.07.01)

- Methods of corrosion protection for metallic components. (442.07.04.06)

- Locations of concrete pressure pipe corrosion monitoring stations. (442.07.05)

- Splice connection method. (442.07.10)

Type and spacing of anodes are dependent on the soil conditions. Soil conditions should be verified before specifying the anode type and spacing. Assumptions used for anode spacings provided for new metallic watermains are as follows:

i. Soil resistivity of 2,000 ohm-cm.
ii. Bitumen coatings on pipe or other components are of no value (i.e., essentially bare).
iii. 150 mm main with copper services should require about 2 mA of cathodic protection current per lineal foot and so in 2,000 ohm-cm soil 50 mA from a 24 lb zinc anode should cover 8.0 m of pipe.
iv. 6.0 m spacing would allow for one anode per joint so discontinuities should not be a problem.
v. A 24 pound zinc anode has a capacity of about 1,000 ma years so the anodes should have a life of about 20 years.

The anode items are titled "*type*" Individual Anode-Item and *"type"* Anode Bank-Item. The reference to *"type"* is to indicate that the complete item title for tender should include the type of anode (i.e., zinc or magnesium) required. (442.10.01)

The test station item is titled *"type"* Test Station-Item. The reference to type is to indicate that the complete item title for tender should include the type of test station (i.e., flush-mounted or post-mounted) required. (442.10.01)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 1109.010	Cathodic Protection for Metallic Watermain Systems
OPSD 1109.011	Cathodic Protection for PVC Watermain Systems
OPSD 1109.012	Cathodic Protection of Existing Metallic Watermains, Exposed Service or Pipe Method

OPSD 1109.013	Anode Installation Over Pipe Method for Existing Metallic Watermains
OPSD 1109.014	Vertical Anode Bank at Service
OPSD 1109.015	Horizontal Anode Bank at Service
OPSD 1109.025	Waterproofing of Splices

CONSTRUCTION SPECIFICATION FOR PIPELINE AND UTILITY INSTALLATION IN SOIL BY HORIZONTAL DIRECTIONAL DRILLING

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450-A **Commentary**

450.01 SCOPE

This specification covers the requirements for the installation of underground pipelines, conduits, cable, or ducts using the trenchless technology known as horizontal directional drilling.

450.01.01 Significance and Use of Appendices

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be as specified in the Contract Documents.

450.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

450.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 401	Trenching, Backfilling, and Compacting
OPSS 404	Support Systems
OPSS 409	Closed-Circuit Television Inspection of Pipelines
OPSS 491	Preservation, Protection, and Reconstruction of Existing Facilities
OPSS 492	Site Restoration Following Installation of Pipelines, Utilities and Associated Structures
OPSS 517	Dewatering for Excavations
OPSS 539	Temporary Protection Systems

450.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Active Interference means electrical interference created by magnetic fields and radio frequencies such as power lines.

Backreamer means a cutting head designed for the soil conditions and is attached to the leading end of a drill string to enlarge the pilot bore during a pullback operation to enable installation of the pipelines, conduits, cable, or ducts.

Bore Path means a drilled path according to the grade and alignment tolerances specified in the Contract Documents.

Frac Out means a condition when the drilling fluid's pressure in the bore is sufficient to overcome the in situ vertical confining stress, thereby fracturing the soil and allowing the drilling fluids to migrate to the surface at an unplanned location.

Drill Fluid Control Points means locations along the bore path when control points are constructed to manage drill fluids.

Drilling Fluids means a mixture of water and additives, such as bentonite, polymers, surfactants, and soda ash, designed to block the pore space on a bore wall, reduce friction in the bore, and to suspend and carry cuttings to the surface.

Entry Point means the location or excavation from which the bore is initiated for the installation of the pipelines, conduits, cable, or ducts.

Exit Point means the location or excavation to which the bore is directed for the installation of the pipelines, conduits, cable, or ducts.

Guidance System means an electronic system capable of indicating the position, depth, and orientation of the drill head during the drilling process.

Horizontal Directional Drilling (HDD) means directional boring or guided horizontal boring.

Inadvertent Returns means the flow of unexpected fluids encountered during the drilling process.

Loss of Circulation means the discontinuation of the flow of slurry in the bore back to the entry or exit point or at drill fluid control points.

Passive Interference means electrical interference created by adjacent structures, buried metal, salt water, and minerals in the soil.

Pilot Bore means the initial bore to set horizontal and vertical alignment between the connecting points.

Pipelines, Conduits, Cable, or Ducts Installation means a single pipeline, conduit, cable, or duct installed into a bore path. The pipeline, conduit, cable, or duct may or may not have a tracer wire attached to it.

Pullback means that part of the HDD method in which the drill string is pulled back through the bore path to the entry point, usually installing the pipelines, conduits, cable, or ducts at the same time.

Reamer means a cutting tool specifically designed for in situ ground conditions. It is attached to the leading end of a drill string to enlarge the pilot bore prior to or during a pullback operation to enable installation of the pipelines, conduits, cable, or ducts, and deliver drill fluids into the bore and mix bore cuttings to form flowable slurry.

Reaming means a process for pulling or pushing a tool attached to the end of the drill string through the bore path to enlarge the bore and mix the cuttings with the drilling fluid. This could include multiple passes prior to pipelines, conduits, cable, or ducts pullback.

Rock means natural beds or massive fragments of the hard, stable, cemented part of the earth's crust that are igneous, metamorphic, or sedimentary in origin, that may or may not be weathered and includes boulders having a volume of 0.5 m^3 or greater.

Slurry means a mixture of soil cuttings and drilling fluid.

Soil means all soils, except those defined as rock, and excludes stone masonry, concrete, and other manufactured materials.

Staging Area means an area set aside for the Contractor's drilling and pipe assembly operations.

Strike Alert means a system, audio or visual or both, that is intended to alert and protect the operator in the case of inadvertently drilling into an electrical Utility cable.

450.04 DESIGN AND SUBMISSION REQUIREMENTS

450.04.01 Submission Requirements

The following information shall be submitted to the Contract Administrator 14 Days prior to the commencement of pipe bursting operations, or as specified in Contract Documents:

a) A work plan outlining the procedure and schedule to be used to execute the work.

b) A list of personnel, including backup personnel, and their qualifications and experience.

c) A traffic control plan.

d) A drilling fluid management plan, including source of fresh water and necessary permits or approvals; type of drilling fluids and potential additives and their Safety Data Sheets (SDS); method of drilling fluid containment; method of recycling drilling fluid, as applicable; method of transporting drilling fluids off site; disposal of excess drill fluids as specified in the Contract Documents; and method to continually monitor fluid properties and pressure throughout the course of drilling and pullback operations to anticipate drilling fluid related problems before they occur; and potential environmental impacts and emergency procedures and associated contingency plans.

e) A health and safety plan including the company safety manual, emergency procedures, and a list of emergency personnel contact information.

f) A drilling plan indicating the proposed type and size of directional drilling equipment; location and dimensions of staging areas; diameter of pilot hole and number and size of backreamers; guidance system; field determined elevations of the surface topography along the bore path; field determined elevations and locations of all existing Utilities within 1.5 m of the bore path; rod-by-rod profile data along the bore path; location of drill fluid control points; identification of active and passive interference along with appropriate compensation measures; method to continuously monitor and record pipelines, conduits, cable, or ducts pipe tensile installation forces and down bore fluid pressures; pipe protection procedures; pipe gripping procedures; and temporary protection systems.

g) Contingency plans for the following potential conditions, or as specified in Contract Documents:

   i. Alignment passing through unforeseen obstructions or buried structures.

   ii. Deviation from required alignment and grade.

   iii. Damage to other existing Utilities.

   iv. Soil heaving or settlement.

   v. Contaminated soil or water.

   vi. identifying potential environmental impacts and emergency containment and clean-up procedures.

h) Work permits required under the authorities having jurisdiction necessary to complete the work.

450.05 MATERIALS

450.05.01 Drilling Fluids

Drilling fluids shall be appropriately mixed for the anticipated in situ ground conditions. Only bentonite and drilling equipment manufacturer-approved polymers shall be permitted for use as drilling fluids. All additives used shall be chemically inert, biodegradable, and non-toxic. No petroleum-based or detergent additives shall be permitted.

450.05.02 Pipe Materials

Pipe and fitting type, class, and size shall be as specified in the Contract Documents.

450.05.03 Tracer Wire

Type and number of tracer wires used shall be as specified in the Contract Documents.

450.06 EQUIPMENT

450.06.01 Directional Drilling Equipment

450.06.01.01 General

The directional drilling equipment shall consist of a directional drill rig and a fluid mixing and delivery system with sufficient capacity to complete the pipelines, conduits, cable, or ducts installation.

The drill rig and all associated equipment shall be in acceptable mechanical working order.

All drill operations and equipment shall be controlled by competent, experienced, and trained personnel.

450.06.01.02 Drilling Rig

The directional drilling rig shall:

a) consist of a hydraulically powered boring system to rotate, push, and pull the drill rod into the ground at a variable angle while delivering a pressurized fluid mixture to a guidable drill head.

b) have drill rod that is suitable for both the drill and the pipelines, conduits, cable, or ducts pipe installation.

c) contain a drill head that is steerable, equipped with the necessary cutting surfaces and fluid jets, and be suitable for the anticipated ground conditions.

d) have adequate reamers and down-bore tooling equipped with the necessary cutting surfaces and fluid jets to facilitate the pipelines, conduits, cable, or ducts installation and be suitable for the anticipated ground conditions.

e) support a guidance system to accurately guide boring operations.

f) be anchored to withstand the pushing and pulling forces required to complete the pipelines, conduits, cable, or ducts installation.

g) contain an active strike alert system and be properly grounded during all operations.

450.06.01.03 Guidance System

The guidance system shall be setup, installed, and operated by trained and experienced personnel. The operator shall be aware of any active and passive interference that may interfere with the guidance of the system.

The type of guidance system shall be suitable for the design bore path and as specified in Contract Documents. The calibration of the guidance system shall be verified daily prior to use.

450.06.01.04 Drill Fluid Mixing and Delivery System

The drill fluid mixing system shall be of sufficient size to thoroughly and uniformly mix the required drilling fluid.

The delivery system and reamers shall have sufficient flow and capacity to ensure that the slurry volumes are adequate for the length and diameter of the final bore and in situ ground conditions.

450.07 CONSTRUCTION

450.07.01 General

The Contract Administrator shall be notified at least 48 hours in advance of commencement of the drilling operations. Operations shall not begin until proper preparations are made.

When strike alerts are provided on a drilling rig, they shall be activated during drilling and maintained at all times.

The location of all Utilities in the work area shall be identified and located prior to the commencement of the drilling operations. If prior to commencement of drilling operations, a Utility is found to exist that would conflict with the installation of the pipe, the Contract Administrator shall be notified immediately.

450.07.02 Site Preparation

The site shall be graded or filled to provide a level work area for the drilling rig. No alterations beyond what is required for HDD operations are to be made. All activities shall be confined to designated work areas.

450.07.03 Preservation and Protection of Existing Facilities

Preservation and protection of existing facilities shall be according to OPSS 491.

Minimum horizontal and vertical clearances to existing facilities shall be maintained as specified in the Contract Documents. Clearances shall be measured from the nearest edge of the largest reamer to the nearest edge of the facility that is parallel to or crossed by the pipeline or Utility being constructed.

Existing underground facilities shall be exposed to verify their horizontal and vertical locations when the bore path comes within 1.0 m horizontally or vertically of the existing facility. Existing facilities shall be exposed by non-destructive methods. The number of exposures required to monitor work progress shall be as specified in the Contract Documents.

Should it become necessary to excavate or disturb existing Utilities to retrieve lost boring equipment, all relevant approvals shall be obtained.

450.07.04 Transporting, Unloading, Storing, and Handling Materials

Manufacturer's recommendations for transporting, unloading, storing, and handling of materials shall be followed.

450.07.05 Trenching, Backfilling, and Compacting

Trenching, backfilling, and compacting for entry and exit points or other locations along the bore shall be according to OPSS 401.

450.07.06 Support Systems

Support systems shall be according to OPSS 404.

450.07.07 Dewatering

Dewatering shall be according to OPSS 517.

450.07.08 Temporary Protection Systems

The construction of all temporary protection systems shall be according to OPSS 539. Protection shall be provided when the stability, safety, or function of an existing roadway, railway, watercourse, other works, or proposed works may be impaired. Protection may include sheathing, shoring, and piles necessary to prevent damage to works or proposed works.

450.07.09 Drilling Fluid Management

To manage drilling fluids and to mitigate the development of inadvertent returns, a containment, collection, and disposal method shall be employed. The clean-up and disposal of drilling fluids shall be managed in accordance with the drilling fluid management plan.

Fluid properties shall be continually monitored throughout the course of drilling and pullback operations to ensure that the drill fluid properties remain appropriate for the in-situ ground conditions.

450.07.10 Pilot Bore

The pilot bore shall be drilled along the bore path in accordance with the grade, alignment, and tolerances as specified in the Contract Documents. Drill rod and pipelines, conduits, cable, or ducts bend radius shall be taken into consideration when completing the pilot bore.

In the event the pilot bore does deviate, the Contract Administrator shall be notified. The Contract Administrator may require pullback and re-drill from the location along the bore path prior to the deviation. In the event that a drilling fluid frac out, inadvertent returns, or loss of circulation occurs during pilot bore drilling operations, the Contract Administrator shall be advised of the event and of the action taken.

If a drill hole beneath a road shall be abandoned, the hole shall be backfilled with grout or bentonite to prevent future subsidence.

450.07.11 Reaming

The bore shall be reamed to the appropriate size with tooling that is adequate for the in-situ ground conditions and the pipelines, conduits, cable, or ducts that is to be installed.

The final staged ream shall not exceed 1.5 times the pipelines, conduits, cable, or ducts pipe largest outside diameter.

The drilling mud in the annular region shall not be removed after installation, but permitted to solidify and provide support for the pipe and surrounding soil.

450.07.12 Pipelines, Conduits, Cable, or Ducts Installation

450.07.12.01 General

The pipelines, conduits, cable, or ducts shall be jointed and installed according to manufacturer's recommendations and shall be protected from damage in the staging area and during pullback.

The minimum allowable bending radius for the pipelines, conduits, cable, or ducts shall not be exceeded during installation at the entry point, exit point, or any other location along the bore path.

The pipelines, conduits, cable, or ducts shall be allowed to recover prior to the connection to a new or existing facility is made. Pipelines, conduits, cable, or ducts recovery time shall be according to the manufacturer's recommendations.

Tracer wire shall be supplied and installed along with the pipelines, conduits, cable, or ducts, as specified in the Contract Documents.

450.07.12.02 Pullback

After completion of reaming the bore to the required diameter, the pipelines, conduits, cable, or ducts shall be pulled into the bore path as soon as possible.

The pullback operation shall be a continuous operation, if possible, until the pipelines, conduits, cable, or ducts pipe is installed.

The pipelines, conduits, cable, or ducts pipe gripping method shall allow the full tensile rating of the pipelines, conduits, cable, or ducts to be developed.

A swivel of sufficient capacity shall be used between the reamer and the pipelines, conduits, cable, or ducts being installed. The swivel shall prevent rotational forces from the reamer being transferred to the pipelines, conduits, cable, or ducts.

When specified in the Contract Documents, a pipe load measuring device shall be used to ensure that the manufacturer's recommended pullback force is not exceeded. (i.e., gauges, down-hole devices, weak links).

When specified in the Contract Documents, a weak link or breakaway connector shall be used to prevent excess pulling force from damaging the pipelines, conduits, cable, or ducts.

The pipelines, conduits, cable, or ducts shall be inspected for damage, when visible, at excavation pits and when it exits the bore.

Any damage shall be repaired to the satisfaction of the Contract Administrator.

450.07.13 Pipelines, Conduits, Cable, or Ducts Testing

When required, pipelines, conduits, cable, or ducts testing shall be as specified in the Contract Documents.

450.07.14 Record Keeping

Verification record requirements of the alignment and depth of the installed pipelines, conduits, cable, or ducts shall be as specified in the Contract Documents. A copy of the verification records shall be given to the Contract Administrator at the completion of the HDD operations.

450.07.15 Closed Circuit Television (CCTV) Inspection

When required by the Contract Documents, a CCTV inspection shall be according to OPSS 409.

450.07.16 Site Restoration

When required, site restoration shall be according to OPSS 492.

450.07.17 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

450.07.18 Tracer Wire

Proper techniques shall be applied to safely pull all tracer wires during the drilling operation. Welding a hook to connect the tracer wires on to the pull head shall be required.

450.09 MEASUREMENT FOR PAYMENT

450.09.01 Actual Measurement

450.09.01.01 Pipelines, Conduits, Cable, or Ducts Installation by HDD

Measurement for a pipelines, conduits, cable, or ducts installation shall be by length, in metres, along the centreline of the useable pipelines, conduits, cable, or ducts between final connection points or work completed. No additional payment shall be made for end pieces to achieve the design elevation.

450.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

450.10 BASIS OF PAYMENT

450.10.01 Pipelines, Conduits, Cable, or Ducts Installation by HDD, *"Diameter, Material, and Use of Pipelines, Conduits, Cable, or Ducts,"* - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

Appendix 450-A, November 2021
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

The designer should include the following in the Contract Documents:

- Grade and alignment tolerances. (450.03)

- Subject to the scope of operations, the designer may wish to specify in the Contract Documents a more detailed work plan prior to the commencement of work, particularly for multiple pipe installations, multiple Day projects, congested work areas, or environmentally sensitive sites. (450.04)

- Consideration should be given to adjusting the submission timeline to be shorter or longer, as needed. When deciding, consider including provisions for time required by the Contract Administrator for reviewing the submission and providing feedback to the Contractor in a timely fashion, prior to commencement of pipe bursting operations. (450.04.01)

- Disposal of excess drill fluids. (450.04.01)

- Contingency plan. (450.04.01)

- The designer should give careful consideration, in consultation with the pipe manufacturer, to ensure the installed pipe is suitable to resist all installation and long-term in-service loads, the design shall specify the minimum pipe and fitting type, class, size, maximum bend radius, and safe tensile load. (450.05.02)

- To ensure successful continuity of at least one tracer wire, post installation, consideration should be given towards the type and number of tracer wires to account for the various forces that the tracer wires may be subjected to (including, but not limited to bursted pipe fragments, over burden materials, etc.). (450.05.03)

- Guidance system. (450.06.01.03)

- The designer should specify the following elements in the Contract Documents: the minimum horizontal and vertical clearances to existing facilities; and the number of exposures required to monitor the work progress. (450.07.03)

- The designer should specify the trenching, backfilling, and compacting requirements for entry and exit points or other locations along the bore, if different than the requirements in OPSS 401. (450.07.05)

- The designer may consider special provisions for backfilling and compacting, including the consideration of unshrinkable backfill to ensure proper compaction in critical locations. (450.07.05)

- The designer should specify the support systems requirements, if different than the requirements in OPSS 404. (450.07.06)

- The designer should provide the necessary grade, alignment, and tolerances for the pipelines, conduits, cable, or ducts installation in the Contract Documents. (450.07.10)

- The designer may consider a lower reaming diameter than that specified if the ground conditions are suitable. The designer should understand that multiple passes of the reaming operation can be expected and is to be included in the unit cost for the pipelines, conduits, cable, or ducts installation. (450.07.11)

- The designer should specify the method of verifying the pipelines, conduits, cable, or ducts installation location. The designer may consider the use of the reporting information available from the drill rig, daylighting, installation of tracer wire with the pipelines, conduits, cable, or ducts, or the use of acoustic/magnetic locating equipment. The designer should consider specifying the required maintenance, submission of a daily drill records, drilling fluid pressures, records of any problems encountered, along with alignment and depth of bore. (450.07.12)

- The designer should review pipelines, conduits, cable, or ducts-jointing specifications as provided by manufacturers. Experienced personnel with jointing accreditation may be added as a requirement of the Contract Documents depending on the type of installation. For fusible pipe pipelines, conduits, cable, or ductss, the pipe should be completely jointed prior to the pull back operation to avoid delays during installation. All pipe jointing shall be to manufacturer specifications. (450.07.12.01)

- The designer should specify the supply and installation of the tracer wire with the pipelines, conduits, cable, or ducts. (450.07.12.01)

- When required, the designer should specify the use of a pipe load measuring device to ensure that the manufacturer's recommended pullback force is not exceeded. (450.07.12.02)

- For certain pipelines, conduits, cable, or ducts installations, the designer may wish to consider the requirement of a weak link or breakaway connector or pull load measuring system to prevent excess pulling force from damaging the pipelines, conduits, cable, or ducts. (450.07.12.02)

- The designer may consider specifying physical pipelines, conduits, cable, or ducts testing through the use of pipelines, conduits, cable, or ducts coupons from the exit pit. In addition, in situ pressure or vacuum tests can be used to ensure the integrity of the pipelines, conduits, cable, or ducts installation. (450.07.13)

- Record keeping. (450.07.14)

- CCTV. (450.07. 15)

- The designer's careful preparation of the project should greatly assist in the success of the installation. However, there may always be a risk of encountering unexpected problems that may require a fair resolution for payment. It is recommended that the designer consider a process regarding payment for failed attempts for inclusion in the Contract Documents. (450.10)

- The tender item description for pipelines, conduits, cable, or ducts installation by HDD shall include reference to one or more of the attributes shown (i.e., diameter of pipelines, conduits, cable, or ducts, pipelines, conduits, cable, or ducts material, use of pipelines, conduits, cable, or ducts, to be complete). (450.10.01)

The specification was written to encompass the majority of HDD drilling operations for small and medium sized projects with diameters generally up to 914 mm and drill lengths of less than 1,000 m. The basic design considerations should always include: minimum cover to prevent inadvertent drill fluid frac out releases; geology of the area, including future river "scour" or meander projections; site logistics; connection requirements; and site-specific issues (e.g., river crossings, wet lands, and archaeological sites).

Geotechnical and site condition information are required for a successful project design, and to ensure that the Contractor has the proper equipment and materials (i.e., drilling fluid mixtures, methods, or equipment), and pipe design.

The principal safety concern in HDD is ensuring that the drilling equipment does not contact existing underground infrastructure. The risk of contacting other Utilities can be mitigated by knowing the precise locations of all underground Utilities in close proximity to the HDD bore path. Detailed knowledge of all subsurface Utility locations is a critical component of a directional drilling project, and this information should be included in the Tender Documents.

Throughout the commentary, the designer is provided with guidance on the consideration of Quality Assurance and Quality Control (QA/QC) techniques. However, it should be noted that evolving technology and techniques for improved QA/QC are in development and the designer should refer to trade publications to identify the latest available methods. In all cases, the designer should specify the quality assurance acceptance criteria to be used for each specific project.

Related Ontario Provincial Standard Drawings

No information provided here.

CONSTRUCTION SPECIFICATION FOR GRAVITY PIPE AND SEWER REHABILITATION BY CURED-IN-PLACE PIPE

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460 **Commentary**

460.01 SCOPE

This specification covers the requirements for the rehabilitation of gravity pipe and sewer by the installation of a tight fitting cured-in-place pipe liner.

460.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be as specified in the Contract Documents.

460.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

460.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 401	Trenching, Backfilling, and Compacting
OPSS 404	Support Systems
OPSS 409	Closed-Circuit Television Inspection of Pipelines
OPSS 491	Preservation, Protection, and Reconstruction of Existing Facilities
OPSS 492	Site Restoration Following Installation of Pipelines, Utilities, and Associated Structures
OPSS 517	Dewatering of Pipeline, Utility, and Associated Structure Excavation
OPSS 539	Temporary Protection Systems

CSA Standards

B64.5-07	Double Check Valve (DCVA) Backflow Preventers [Part of B64 Series-07, Backflow Preventers and Vacuum Breakers Compendium]
S6-14	Canadian Highway Bridge Code

ASTM International

D 638-14	Standard Test Method for Tensile Properties of Plastics
D 790-17	Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
D 2990-17	Standard Test Methods for Tensile, Compressive, and Flexural Creep and Creep-Rupture of Plastics
F 1216-16	Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube

F 1743-17 Standard Practice for Rehabilitation of Existing Pipelines and Conduits by Pulled-in-Place Installation of Cured-in-Place Thermosetting Resin Pipe (CIPP)

F 2019-11 Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Pulled in Place Installation of Glass Reinforced Plastic (GRP) Cured-in-Place Thermosetting Resin Pipe (CIPP)

American Water Works Association (AWWA)

C510 Double Check Valve Backflow Prevention Assembly

460.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Cured-In-Place Pipe (CIPP) Lining means the rehabilitation of existing pipe in place by installation of a tube with one or more layers of flexible needled felt or an equivalent woven or non-woven material capable of carrying resin.

Resin means a general purpose, unsaturated, thermoset material and catalyst system or an epoxy material and hardener that is compatible with the inversion process.

460.04 DESIGN AND SUBMISSION REQUIREMENTS

460.04.01 Design Requirements

The engineering design shall be in accordance with ASTM F 1216 with the following criteria:

a) Design conditions:

i. CIPP design shall assume fully deteriorated condition of the original pipe.
ii. CIPP design shall assume no bonding to the original pipe wall.

b) Parameters for design:

i. Design life of 50 years.
ii. Safety factor of 2 on external load.
iii. Groundwater depth is full soil depth, unless otherwise known.
iv. Soil modulus of 6.9 MPa, unless otherwise known.
v. Soil density of 2124 kg/m^3, unless otherwise known.
vi. Load according to S6-14 of 166.6kN.
vii. Minimum ovality of 2%, unless otherwise known. If the host pressure pipe ovality exceeds 2% (for forcemains), the F1216 X1 fully deteriorated pressure pipe design should not be used and a different design method should be employed.
viii. Minimum depth of 4 metres to top of pipe, unless otherwise known.

460.04.02 Submission Requirements

The design for the lining shall be submitted to the Contract Administrator for approval at least 14 Days prior to installation. The design calculations shall show technical assumptions, identify the design formulas used, and show the liner wall thickness.

The engineering design shall illustrate the installation conditions (i.e., depth of pipeline, water table, pipe invert and crown, ovality condition of host pipe, and full details of the parameters used).

Flow capacity calculations for the lined pipe shall be provided upon request of the Contract Administrator.

The design work shall bear the seal and signature of an Engineer.

The following information shall be submitted to the Contract Administrator at least 7 Days prior to commencing Work:

a) A work plan outlining the schedule, procedures, and work site.

b) A list of personnel, including backup personnel, with their qualifications and experience.

c) A traffic control plan including pedestrian movements.

d) A project-specific safety plan, confined space entry and emergency procedures. The company's safety manual should also be submitted.

e) Sewer flow by-pass plan, when specified in the Contract Documents.

f) Manufacturer's technical data containing complete information on:

   i. Material composition, physical properties, and dimensions of the new product.
   ii. Recommendations for transportation, handling, and storage.
   iii. Repair of product damaged during installation.
   iv. Installation details.
   v. Product curing procedures listing the curing temperature and duration, including cool down time for the product.

g) Contingency plans for the following potential conditions:

   i. Damage to the existing service connections.
   ii. Improper placement of the CIPP.
   iii. Damage to the host pipe.
   iv. CIPP's failure to achieve structural integrity.

h) A sample letter to residents impacted by the work shall be submitted to the Contract Administrator for approval 14 Days prior to commencing the work. As a minimum, the letter shall include:

   i. Contract number.
   ii. Emergency contact name and number.
   iii. Nature of work and expected service interruptions.
   iv. Anticipated start date and duration.
   v. Working hours.

i) For heat cured systems, a detailed plan for managing curing effluent, including containment, flushing, sampling, testing, treatment and disposal.

460.05 MATERIALS

460.05.01 Liner

The CIPP liner material shall have the following minimum characteristics:

a) Initial Structural Properties of the Lining

i. Flexural modulus 1,724 MPa according to ASTM D 790.
ii. Flexural strength 31 MPa according to ASTM D 790.
iii. Tensile strength, for pressure pipes only, 21 MPa according to ASTM D 638.
iv. 50-year creep reduction according to ASTM D 2990.

b) Material Properties for Pipelines

The finished CIPP liner shall meet the chemical resistance requirements in accordance with ASTM F 1216 and shall be resistant to all chemicals and agents found in the liquid flow. .

460.05.02 Tube

The CIPP tube shall consist of one or more layers of flexible needled felt or an equivalent woven or non-woven material capable of carrying resin able to withstand installation pressures and curing temperatures and shall be compatible with the resin system used. The material shall be capable of stretching to fit irregular pipe sections and negotiate bends. The inner layer and the finished pipe surface shall have an impermeable plastic coating for enhancement of corrosion protection, flow, and abrasion properties of the liner. The tube shall be fabricated to a size that fits tightly to the internal circumference and the length of the original conduit, when installed.

The tube shall be marked at regular intervals not to exceed 1.5 m along its entire length with the manufacturer's name or identification symbol.

460.05.03 Resin

The CIPP resin shall meet the requirements of ASTM F 1216, ASTM F 1743, or ASTM F 2019.

460.05.04 Calibration Hose

If a calibration hose is used for inflation of the CIPP liner system, it shall comply with the requirements of ASTM F 1743.

460.05.05 Lubricant

The lubricant used shall be a non-toxic oil-based product that has no detrimental effects on the tube and does not support the growth of bacteria, and does not adversely affect the fluid to be transported. Lubricant shall not be used in processes with permeable coatings.

460.05.06 Double Check Valve Backflow Preventers

Double check valve backflow preventers shall be according to CSA B64.5 or AWWA C510.

460.07 CONSTRUCTION

460.07.01 General

The Contract Administrator shall be notified at least 48 hours in advance of starting work.

The exact size and length of all existing pipes to be rehabilitated shall be confirmed prior to undertaking the manufacturing of any tubes.

All required equipment shall be on-site and in satisfactory working order prior to commencing the installation of a lining section.

Work shall progress and continue as required to minimize downtime on pipelines and out-of-service periods on laterals.

At least 7 Days prior to any interruption in service, the Owner shall advise, in writing, all residents who may be affected by the rehabilitation process about the nature, duration, and expected date of any interruption in service and the contact information of the Contractor. The Contractor shall notify all affected residents or businesses of the specific time of the disruption to their service at least 24 hours in advance and shall endeavour to minimize their inconvenience. During the course of the rehabilitation and any associated service interruption, the residents shall be kept regularly informed regarding any matters that affect them.

460.07.02 Preservation and Protection of Existing Facilities

Preservation and protection of existing facilities shall be according to OPSS 491.

460.07.03 Transporting, Unloading, Storing, and Handling Materials

Manufacturer's recommendations for transporting, unloading, storing, and handling of materials shall be followed.

460.07.04 Trenching, Backfilling, and Compacting

Trenching, backfilling, and compacting for any access pits shall be according to OPSS 401.

460.07.05 Support Systems

Support systems shall be according to OPSS 404.

460.07.06 Dewatering

Dewatering shall be according to OPSS 517.

460.07.07 Temporary Protection Systems

The construction of temporary protection systems shall be according to OPSS 539.

Where the stability, safety, or function of an existing roadway, railway, watercourse, other works, or proposed works may be impaired due to the method of operation, protection shall be provided. Protection may include, but not be limited to, sheathing, shoring, and piling where necessary to prevent damage to such works or proposed works.

460.07.08 Temporary Service

460.07.08.01 Sewer Lining, Sewer Flow By-Pass Plan

When specified in the Contract Documents, during the execution of the work, the sewer flow shall be by-passed around the pipeline being relined.

Pumps and by-pass lines shall be of adequate capacity and size to handle all flows.

When interruption of sewer line flows is necessary to properly conduct the inspection and rehabilitation operations, acceptable methods of flow control shall be used. The Contractor is to make all necessary arrangements with the owners, property managers, and residents of each building. The Contractor shall contact all property owners or tenants or both to coordinate the repair work to the sewer and minimize any impact to the residents and businesses.

Unless otherwise specified in the Contract Documents, during the inspection and rehabilitation, sewer flows shall be bypassed in order to enable proper inspection of the pipe invert. After the work is completed, flows shall be restored to normal.

On all liner installation dates, the Contractor shall maintain a primary and stand-by by-pass pump and pump power supply on-site. Sufficient power supply and hoses shall be on-site in order to allow the pump to discharge into the next downstream sewer section. The stand-by by-pass pump and power supply shall be of an equal or better capability than the primary by-pass pump and power supply. Unless otherwise specified in the Contract Documents, no by-pass pumps or related equipment shall be disconnected or removed from the sewer or work site until after all service connections have been reinstated and the Contractor has recorded the post-installation video.

All by-pass pumping shall be in place and operational prior to the final pre-installation inspection. All by-pass pumping capacities and configurations shall be approved by the Contract Administrator prior to the actual liner installation date. When specified in the Contract Documents, all by-pass pumps and related equipment shall be silenced equipment or contained within an acceptable sound reduction structure.

460.07.09 Preparation of Existing Pipeline

A pre-installation inspection report shall be completed and submitted to the Contract Administrator prior to the commencement of the pipeline rehabilitation.

The existing pipeline to be rehabilitated shall be prepared in accordance with the manufacturer's requirements for CIPP installation. Debris, grease, and other deposits shall be removed from the pipeline. Any obstructions remaining after flushing and cleaning shall be removed without damaging the existing pipeline walls. All roots that interfere with the lining installation shall be removed. Any calcite build-up in the existing pipeline that interferes with the CIPP shall be removed by means that do not damage the existing pipeline walls. Protrusions from deposits such as calcite shall not exceed the maximum allowable values as specified in ASTM F 1216.

Existing protruding service laterals that interfere with the installation or performance of the liner shall be removed without damage to the lateral or the pipeline wall. Flail type equipment is not permitted for the removal of protruding laterals.

The Contractor shall also install a screen in the downstream maintenance hole in order to catch any material, including cut outs from service connection openings that may migrate downstream. Such material shall be removed from the maintenance hole.

If the pre-installation inspection reveals an obstruction such as a protruding service connection, a dropped joint, or a collapse that prevents the inversion process and it cannot be removed by conventional sewer cleaning equipment, then the Contractor shall attempt a trenchless technique to remove or repair the obstruction. Any necessary excavation shall be approved in writing by the Contract Administrator prior to the commencement of the work.

When the filling of voids is necessary to ensure structural integrity of the pipeline and to prevent bridging of the liner, the Contractor shall submit a detailed procedure outlining the process and materials to be used to fill the voids to the Contract Administrator for approval.

460.07.10 Closed-Circuit Television (CCTV) Inspection

CCTV inspection shall be according to OPSS 409.

Unless otherwise specified in the Contract Documents, two CCTV inspections of each pipeline section shall be completed as follows:

a) Post Preparation Video Inspection

After completion of the preparation of a pipeline section, a video inspection of the full length of the pipeline section shall be made and submitted to the Contract Administrator. Prior to the delivery of the 24-hour service interruption notice and any lining installation taking place, approval of the prepared section shall be obtained from the Contract Administrator.

b) Post-Lining Final Video Inspection of Complete Rehabilitation

After completion of all work required for the lining of the pipeline section, a video inspection of the full length of the pipeline section shall be made and submitted to the Contract Administrator for approval of the work.

The final video recording shall be submitted to the Contract Administrator for approval immediately upon completion of the work, but no more than 48 hours after the lining installation in each section.

The inside wall of the access point at each end of the pipeline section shall be clearly visible on the inspection videotape.

460.07.11 Cured-In-Place Pipe Lining Installation

The installation of the CIPP lining shall be according to the manufacturer's procedure.

Before installation begins, the Contractor shall obtain manufacturer's recommendations of the minimum pressure required to hold the tube tight against the existing pipes and the maximum allowable pressure, so as not to damage the existing pipe. Once the installation has started, pressure shall be maintained between the minimum and maximum pressures and documented until the installation has been completed.

The existing pipes shall be dewatered for any CIPP installation that does not use an inversion method to expand the tube against the pipe wall.

460.07.12 Curing

The CIPP installation shall be according to ASTM F 1216, ASTM F 1743, or ASTM F 2019. Qualified personnel shall monitor the curing process and maintain written records, including lining temperatures and internal pressure and/or UV light intensity and duration throughout the curing process. These records shall be made available to the Contract Administrator upon request.

The CIPP shall be inserted and cured in accordance with the manufacturer's parameters and procedures required for the process, or as specified in Contract Documents.

Readings shall be made and recorded at intervals as specified by the liner system manufacturer.

a) Heat Cured Systems: Measure and record the interface temperature at the downstream and upstream ends of the liner as well as any accessible intermediate access points with a thermocouple at the crown and invert of the liner. The time required for the cure shall be determined by the temperature monitoring and shall be adjusted to suit the lengths, diameter, thickness, field conditions, and ambient temperature applicable to each pipe lining section.

b) UV Cured Systems: Measure and record the inner surface temperature of the liner as well as the light intensity, number of lamps, and light duration during the curing process. The time required for the cure shall be as specified by the liner system manufacturer.

460.07.13 Cool-Down

For heat-cured systems, the CIPP shall be cooled as per resin manufacturer recommendations before relieving the hydrostatic head. Care shall be taken in the release of the static head so that a vacuum does not develop that could damage the newly installed CIPP. Prior to releasing the water used for curing the liner, the water shall be cooled to the ambient temperature as per manufactures specifications after which the water shall be managed in accordance with the detailed discharge plan.

460.07.14 Discharge Requirements

Prior to release to a receiver, it shall be confirmed that the quality of discharge meets the requirements of the receiver.

460.07.15 Inflation Bladder Removal

For pulled-in-place installation techniques where the inflation bladder is designed to not bond to the CIPP, all portions of the bladder material shall be removed from the CIPP.

460.07.16 Liner Termination

The liner termination at and through sections shall be neat and free of obstructions. If the liner termination fails to make a watertight seal with the existing pipe, a seal shall be applied at this point. The sealing process shall use a material compatible with the liner pipe.

In the case where the liner is installed through an existing maintenance hole, the liner shall be trimmed neatly and parged at the spring line of the liner and at the interface between the liner and any other existing sewers or service connections entering into the maintenance hole.

460.07.17 Service Connections and Lateral Reinstatements

Service connection and lateral reinstatement shall be made internally with appropriate remotely operated equipment. Excavation of connections or laterals shall not be allowed. Restored connection or lateral openings shall be cut neatly to full size without over-cutting. Cuts shall be smooth and without residual material left around the opening. Ragged edges or attached material shall not be allowed.

When sewer lateral flow has been interrupted, reinstatement of the lateral shall proceed urgently and with all possible speed to restore lateral flow. Laterals may be reinstated using an initial opening sufficient to restore flow, followed by completion to full reinstatement of 100% open within 24 hours.

460.07.18 Site Restoration

Site restoration shall be according to OPSS 492.

460.07.19 Management of Excess Material

Management of excess material shall be as specified in the Contract Documents.

460.08 QUALITY ASSURANCE

When specified in the Contract Documents, testing shall be in accordance with the requirements of ASTM F 1216. A sample shall be taken from the cured liner at an access point, sufficient in size to meet the

requirements of ASTM D 790 and ASTM D 638. The testing of the sample shall be done by an independent testing laboratory approved by the Contract Administrator.

a) Finished Liner

CIPP samples shall be collected and prepared and physical properties tested in accordance with ASTM F 1216. The minimum number of samples shall be one per each diameter of pipe. Additional samples shall be taken at 500m intervals.

Leakage testing and visual inspection of the CIPP shall be in accordance with ASTM F 1216.

b) Resin

The Contractor shall provide the Owner with an infrared fingerprint of the approved resin for the project from the resin manufacturer.

The Contractor shall supply a sample of the resin when requested by the Contract Administrator. The Owner shall send a sample of the submitted resin from the project to a 3rd party testing laboratory for verification and confirmation.

460.09 MEASUREMENT FOR PAYMENT

460.09.01 Actual Measurement

460.09.01.01 Cleaning and Preparation of Host Pipe

Measurement for host pipe cleaning and preparation shall be by length in metres along the horizontal centreline of the host pipe between connecting points or, if there is no connecting point, to the end of the host pipe.

When the connecting point is a structure, measurement for host pipe cleaning and preparation shall be in metres to the centre of the structure.

460.09.01.02 Product Installation

Measurement for a product installation shall be by length in metres along the horizontal centreline of the product between connecting points or, if there is no connecting point, to the end of the product.

When the connecting point is a structure, measurement for a product installation shall be in metres to the centre of the structure.

460.09.01.03 Service Connection/Lateral Reinstatement

For measurement purposes, a count shall be made of the number of service connections made to the new product.

460.09.02 Plan Quantity Measurement

When payment is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

460.10 BASIS OF PAYMENT

460.10.01 Product Installation, *"type, diameter, or use of product"* - Item Service Connection/Lateral Reinstatement - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Unless otherwise specified in the Contract Documents, compensation for all costs associated with the control of flow for sewers shall be included in the unit prices of the contract.

Any extraction of reaming tools or other equipment, including extraction by excavation, shall be the responsibility of the Contractor and shall be done at no extra cost to the Owner.

Costs associated with the filling of identified voids shall be as specified in the Contract Documents. Any additional work done for the filling of additional voids identified in the video inspection shall be paid as Extra Work. Filling of voids occurring as a result of Contractor's operations shall be done at no extra cost to the Owner.

460.10.02 Closed-Circuit Television Inspection

When the Contract does not contain a separate tender item for CCTV inspection, the Contract price for product installation shall include full compensation for all labour, Equipment, and Material to do the work of CCTV Inspection.

Appendix 460, November 2018
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- By-pass flow. (460.07.08.01)

- The desired format and contents of the report (document, video, or combination thereof). (460.07.09)

- CCTV inspection details. (460.07.10)

- The designer should consider if excessive debris is to be disposed as part of the contract, under separate pay item by weight. (460.07.23)

- Cost of filling voids that have been specifically identified. (460.10.01)

- Designer should specify which curing methods are permitted, and take into consideration the environmental impacts of the selected method. Steam curing may release styrene into the atmosphere. Water curing may release materials used in the lining process to the test water, which may then also be released to the waterbody and/or atmosphere.

The designer should determine if noise restrictions are required, if so, they should be specified in the Contract Documents. (460.07.08.01)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

CONSTRUCTION SPECIFICATION FOR CEMENT MORTAR LINING OF WATERMAINS

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APPENDICES

462-A **Commentary**

462.01 SCOPE

This specification covers the requirements for the rehabilitation of cast or ductile iron watermains by the installation of cement mortar lining.

462.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be as specified in the Contract Documents.

462.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

462.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 401	Trenching, Backfilling, and Compacting
OPSS 404	Support Systems
OPSS 409	Closed-Circuit Television (CCTV) Inspection of Pipelines
OPSS 441	Watermain Installation in Open Cut
OPSS 442	Corrosion Protection of New and Existing Watermains
OPSS 491	Preservation, Protection, and Reconstruction of Existing Facilities
OPSS 492	Site Restoration Following Installation of Pipelines, Utilities, and Associated Structures
OPSS 493	Temporary Potable Water Supply Services
OPSS 517	Dewatering of Pipeline, Utility, and Associated Structure Excavation
OPSS 539	Temporary Protection Systems

American Water Works Association (AWWA)

C602-11	Cement-Mortar Lining for Water Pipelines in Place - 4 in. (100 mm) and Larger

462.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Associated Appurtenance means as defined in OPSS 441.

Fitting means as defined in OPSS 441.

462.04 DESIGN AND SUBMISSION REQUIREMENTS

462.04.01 Submission Requirements

The following information shall be submitted to the Contract Administrator 14 Days prior to the commencement of cement mortar lining operations:

a) If applicable, pre-mixed mortar mix design.

b) Location of access pits.

c) Pipe cleaning procedures.

d) Flushing, disinfection, and commissioning plan.

e) Traffic control plan

462.05 MATERIALS

462.05.01 Cement Mortar Lining

Materials shall be according to ANSI/AWWA C602, except as noted below or, alternatively, a pre-mixed mortar may be submitted for approval by the Contract Administrator.

Chemicals or additives of any kind shall not be permitted, unless prior written approval from the Contract Administrator has been obtained.

462.05.02 Service Boxes

Service boxes shall be as specified in the Contract Documents.

462.05.03 Valves

Valves shall be according to OPSS 441.

462.05.04 Fittings

Fittings shall be according to OPSS 441.

462.05.05 Repair Pipe

Repair pipe shall be polyvinyl chloride pipe or ductile iron pipe according to OPSS 441.

462.05.06 Sacrificial Anodes

Sacrificial anodes shall be according to OPSS 442.

462.06 EQUIPMENT

462.06.01 Cement Mortar-Lining Machine

The cement mortar-lining machine shall be provided with attachments for mechanically trowelling the mortar to produce a smooth surface so that the freshly placed and trowelled mortar is not touched until it has set. The design of the attachment shall be so as to permit operations in pipes that may be out of round, as well as to permit trowelling through bends that deflect up to and including 22.5 degrees.

462.07 CONSTRUCTION

462.07.01 General

The Contract Administrator shall be notified at least 48 hours in advance of starting work.

All fittings and appurtenances removed to facilitate the lining process shall be replaced with new fittings and appurtenances.

All fittings and appurtenances removed shall be delivered to the location specified in the Contract Documents.

462.07.02 Preservation and Protection of Existing Facilities

Preservation and protection of existing facilities shall be according to OPSS 491.

462.07.03 Transporting, Unloading, Storing, and Handling Materials

Manufacturer's recommendations for transporting, unloading, storing, and handling of materials shall be followed.

462.07.04 Trenching, Backfilling, and Compacting

Trenching, backfilling, and compacting for any access pits shall be according to OPSS 401.

462.07.05 Support Systems

Support systems shall be according to OPSS 404.

462.07.06 Dewatering

Dewatering shall be according to OPSS 517.

462.07.07 Temporary Protection Systems

The construction of temporary protection systems shall be according to OPSS 539.

Where the stability, safety, or function of an existing roadway, railway, watercourse, other works, or proposed works may be impaired due to the method of operation, protection shall be provided. Protection may include sheathing, shoring, and piling where necessary to prevent damage to such works or proposed works.

462.07.08 Service Boxes

In advance of working on the street, service boxes shall be located and inspected to ensure that the curb stop is functioning and marked.

Service boxes to be adjusted to final grade and service boxes or curb stops to be replaced shall be identified to the Contract Administrator for approval. After receiving approval, the service boxes shall be adjusted or the service boxes or curb stops shall be replaced.

462.07.09 Temporary Potable Water Supply Services

Temporary potable water supply services shall be according to OPSS 493.

462.07.10 Rehabilitation of Watermains

462.07.10.01 Access Pits

When possible, existing valve and fitting locations shall be used as access pit locations. Access pit locations shall be approved by the Contract Administrator prior to the beginning of construction.

When an access pit is to be located in close proximity to a closed live watermain valve, the active thrust force of the valve shall be addressed to prevent dislocation of the valve or adjacent piping and to ensure safe working conditions.

462.07.10.02 Replacement of Valves

All valves along the length of pipe to be cement mortar lined shall be removed and replaced with the type and size of valve specified in the Contract Documents. In all cases, a jumper wire shall be thermite welded to the existing cast or ductile iron pipe on both sides of the replaced valve.

462.07.10.03 Replacement of Fittings

All fittings along the length of pipe to be cement mortar lined shall be removed and replaced with the type and size of fitting specified in the Contract Documents. In all cases, a jumper wire shall be thermite welded to the existing cast or ductile iron pipe on both sides of the replaced fitting.

462.07.10.04 Cutting of Pipe

Pipes shall be cut so that the ends are smooth and square to ensure proper reconnection.

462.07.10.05 Cleaning Existing Pipe

All rust, tubercles, deposits, loose or deteriorated remains of original coating, and other foreign material shall be removed from the inside of the pipe without damaging the structural integrity of the existing pipe. A cleaning device shall be passed through the pipe as many times as is necessary to obtain results satisfactory to the Contract Administrator. To confirm satisfactory cleaning, a closed-circuit television (CCTV) inspection of the pipe section shall be undertaken.

Solids removed during the cleaning, flushing, and pumping operations shall be captured before flowing into the drainage system and then disposed of as specified in the Contract Documents.

462.07.10.06 Bulkheads on Open Pipe Ends

All pipes shall be closed using a mechanical joint plug or cap anytime there is no work being performed on the pipe. The bulkhead shall be capable of preventing water from entering or exiting the pipe and shall be equipped with a relief valve.

462.07.10.07 Cement Mortar Lining

462.07.10.07.01 General

The lining shall consist of a one-course application of pre-mixed cement mortar, 5 mm $\pm$ 1.5 mm thick, and shall be placed by a machine projecting the mortar against the wall of the pipe and long radius bends, by centrifugal force, without injurious rebound and with sufficient velocity to cause the mortar to be densely packed and to adhere in place. The travel of the machine and the rate of discharge of mortar shall be controlled so as to produce a uniform thickness of lining around the interior and along the length of pipe.

Mortar that has attained its initial set shall not be used.

Mortar of improper consistency that does not provide a dense homogenous lining that holds itself firmly against the pipe surface and all waste materials, spatter, etc., shall be removed from the pipe. Only mortar of suitable consistency and applied with sufficient velocity to adhere firmly to the surface of the pipe shall form the lining.

If any section of the lining fails or shows evidence of failure or unusual irregularity, the faulty section of lining shall be removed to the extent indicated by the Contract Administrator and the pipe re-cleaned and the lining replaced.

462.07.10.07.02 Trowelling

The interior surface of the pipe shall be mechanically trowelled to produce a smooth surface.

462.07.10.07.03 Hand Work

Edges of linings at openings or ends of lined sections shall be neatly finished. Edges shall be rounded or beveled so as to avoid sharp angles or abrupt changes in sections. Surfaces of cement mortar lining to which additional mortar is to be placed shall be moistened just before the mortar is applied.

Hand finishing work in a section of the pipe shall be completed within 24 hours following the machine application of the mortar lining.

462.07.10.08 Closing of Pipe

Immediately upon completion of the cement mortar lining of a section of pipe, all openings in the pipe shall be closed in accordance with the Bulkheads on Open Pipe Ends clause to prevent circulation of air.

462.07.10.09 Curing

As soon as practical, without damaging the cement mortar lining, water shall be introduced into the section of pipe between bulkheads in order to maintain a moist environment.

462.07.10.10 Backflushing

When the lining has achieved sufficient set, all services shall be backflushed with water or another method approved by the Contract Administrator to remove any mortar deposited in them.

462.07.10.11 Obstruction in the Water Services

Should any water service be partially or fully obstructed, the obstruction shall be removed in a manner approved by the Contract Administrator.

462.07.10.12 Closed-Circuit Television (CCTV) Inspection

CCTV inspections shall be according to OPSS 409.

Equipment used for CCTV inspections shall have been used exclusively for the inspection of potable watermain systems in the past.

CCTV inspections shall be carried out on cleaned pipe sections and again on newly lined sections of pipe to ensure proper cleaning or cement mortar application.

All water shall be removed prior to the inspection of the watermain.

If the cleaning or cement mortar lining of any pipe section is unacceptable, the deficiency with the cleaning or mortar lining shall be corrected and the pipe section shall be reinspected.

Any valves, main stops, or other associated appurtenances that are found to have been damaged due to cleaning or lining operations shall be replaced.

462.07.10.13 Repair of Pipe

Upon application of the cement mortar lining, the openings in the pipe shall be closed as soon as possible using polyvinyl chloride pipe or ductile iron pipe and couplings approved by the Contract Administrator. Thrust restraints shall be installed according to OPSS 441. In all cases, a jumper wire shall be thermite welded to the existing cast or ductile iron pipe on both sides of the repair.

462.07.10.14 Sacrificial Anodes

Sacrificial anodes of the type and size specified in the Contract Documents shall be installed at each new valve and cast or ductile iron fitting and at each access pit according to OPSS 442 and the Contract Documents.

462.07.10.15 Hydrostatic Testing

When specified in the Contract Documents, hydrostatic testing shall be carried out according to OPSS 441.

462.07.10.16 Flushing and Disinfecting

Flushing and disinfecting of the completed watermain shall be according to OPSS 441.

462.07.10.17 Return of Watermain to Service and Removal of Temporary Potable Water Supply System

Upon receipt of satisfactory test results on water samples, the watermain shall be flushed and returned to service, permanent water service connections restored, excavations backfilled, and temporary service lines removed without interruption of the water supply.

462.07.11 Site Restoration

Site restoration shall be according to OPSS 492.

462.07.12 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

462.09 MEASUREMENT FOR PAYMENT

462.09.01 Actual Measurement

462.09.01.01 Locating, Inspecting, and Marking Service Boxes

For measurement purposes, a count shall be made of the number of service boxes located, inspected, and marked.

462.09.01.02 Adjusting Service Boxes

For measurement purposes, a count shall be made of the number of service boxes adjusted to final grade.

462.09.01.03 Replacing Service Boxes

For measurement purposes, a count shall be made of the number of service boxes excavated and replaced.

462.09.01.04 Replacing Curb Stops

For measurement purposes, a count shall be made of the number of curb stops excavated and replaced.

462.09.01.05 Access Pits

For measurement purposes, a count shall be made of the number of approved access pits excavated, backfilled, compacted, and restored.

462.09.01.06 Cement Mortar Lining

Measurement of cement mortar lining shall be by length in metres horizontally along the centreline of the pipe being lined.

462.09.01.07 Valves

For measurement purposes, a count shall be made of the number of valves installed along the cement mortar lined pipe.

462.09.01.08 Fittings

For measurement purposes, a count shall be made of the number of fittings installed along the cement mortar lined pipe.

462.09.01.09 Repair of Pipe

For measurement purposes, a count shall be made of the number of sections of pipe repaired.

462.09.01.10 Sacrificial Anodes

For measurement purposes, a count shall be made of the number of sacrificial anodes installed.

462.09.02 Plan Quantity Measurement

When payment is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

462.10 BASIS OF PAYMENT

462.10.01 Locating, Inspecting, and Marking Service Boxes - Item
Adjusting of Service Boxes - Item
Replacing of Service Boxes - Item
Replacing of Curb Stops - Item
Access Pits - Item
***"type, size"* Repair of Pipe - Item**
***"type, size"* Sacrificial Anodes - Item**
Flushing and Disinfecting - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

462.10.02 Rehabilitation of Watermains

462.10.02.01 Cement Mortar Lining - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

Removal and replacement of valves, main stops, curb stops, service boxes, and other associated appurtenances damaged due to cleaning or lining operations shall be at no additional cost to the Owner.

Re-inspection of an unacceptably cleaned or cement lined pipe after correction of a deficiency shall be at no additional cost to the Owner.

462.10.02.02 "*type, size"* Valves - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work of replacing valves.

462.10.02.03 *"type, size"* Fittings - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work of replacing fittings.

462.10.02.04 Obstructions in Water Services

When excavation and repair of a water service is required and not caused by the negligence of the Contractor, payment shall be made as Extra Work.

When water services are partially or fully obstructed due to the ingress of loosened foreign materials from the cleaning or lining process, the obstruction shall be removed at no additional cost to the Owner.

462.10.03 Closed-Circuit Television Inspection

When the Contract does not contain a separate tender item for CCTV inspection, the Contract price for product installation shall include full compensation for all labour, Equipment, and Material to do the work of CCTV Inspection.

Appendix 462-A, November 2019
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Service box requirements. (462.05.02)

- Location for delivery of removed fittings and appurtenances. (462.07.01)

- Type and size of replacement valves. (462.07.10.02)

- Type and size of replacement fittings. (462.07.10.03)

- Disposal of solids from the cleaning, flushing, and pumping operations. (462.07.10.05)

- Type and size of sacrificial anodes to be installed. (462.07.10.14)

The designer should determine if hydrostatic testing of the watermains is required and, if so, it should be specified in the Contract Documents. (462.07.10.15)

The tender item descriptions for repair of pipe should include reference to the attributes shown (i.e., type and size of pipe to be complete). (462.10.01)

The tender item description for sacrificial anodes should include reference to the attribute shown (i.e., type and size of anode to be complete). (462.10.01)

The tender item descriptions for valves should include reference to the attributes shown (i.e., type and size of valve to be complete). (462.10.02.02)

The tender item descriptions for fittings should include reference to the attributes shown (i.e., type and size of fitting to be complete). (462.10.02.03)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 1109.010	Cathodic Protection for Metallic Watermain Systems
OPSD 1109.011	Cathodic Protection for PVC Watermain Systems

CONSTRUCTION SPECIFICATION FOR PIPELINE AND CONDUIT INSTALLATION BY PIPE BURSTING

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463-A **Commentary**

463.01 SCOPE

This specification covers requirements for installation of existing or new pipelines or conduits using the trenchless technology known as pipe bursting.

463.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be as specified in the Contract Documents.

463.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

463.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 401	Trenching, Backfilling, and Compacting
OPSS 404	Support Systems
OPSS 407	Maintenance Hole, Catch Basin, Ditch Inlet, and Valve Chamber Installation
OPSS 409	Closed-Circuit Television (CCTV) Inspection of Pipelines
OPSS 441	Watermain Installation in Open Cut
OPSS 490	Site Preparation for Pipelines, Utilities, and Associated Structures
OPSS 491	Preservation, Protection, and Reconstruction of Existing Facilities
OPSS 492	Site Restoration Following Installation of Pipelines, Utilities and Associated Structures
OPSS 493	Temporary Potable Water Supply Services
OPSS 517	Dewatering for Excavations
OPSS 539	Temporary Protection Systems

463.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Fusion means connecting new pipelines or conduits lengths into a continuous length using elevated temperatures and pressure.

Launch Pit means an access excavation or existing access structure to an existing pipeline or conduit for the insertion of the pipe bursting head and new pipelines or conduits.

Pipe Bursting means the application of a pipe bursting head into the interior of and along the length of an existing pipeline or conduit to split or fracture it. This is so that the existing pipeline or conduit and surrounding

material is opened up to a sufficient size to accommodate the insertion of a new pipelines or conduits in the cavity created, without leaving any significant voids around the new pipelines or conduits. Pipe bursting methods include static, pneumatic, and hydraulic. Pipe bursting is also known internationally as pipe cracking or pipe splitting.

Pull means the installation of one continuous reach of new pipelines or conduits. Generally, a pull shall commence at a launch pit and terminate at a pull pit.

Pull Pit means an access excavation or existing access structure to an existing pipeline or conduit to receive the new pipelines or conduits or pipe bursting head or both.

Structure means a maintenance hole, valve chamber, or other such facility to access the new pipelines or conduits.

463.04 DESIGN AND SUBMISSION REQUIREMENTS

463.04.01 Submission Requirements

The following information shall be submitted to the Contract Administrator 14 Days prior to the commencement of pipe bursting operations, or as specified in the Contract Documents:

a) A work plan outlining the schedule, procedures, launch pit and pull pit locations, and Working Drawings required to execute the work on the new pipelines or conduits, service laterals, and structures.

b) A list of personnel, including backup personnel, their qualifications, and experience.

c) A traffic control plan.

d) Safety plan, including the contracting company safety manual and emergency procedures.

e) When fusion joining is used, written record of current training showing that the operator has been fully trained in the use of the fusion equipment by an authorized representative of the fusion equipment manufacturer and the new pipelines or conduits manufacturer or, when applicable, certified by the Owner or Utility for which the work is being completed.

f) When applicable, new pipelines or conduits bypass and temporary supply system plans, including installation, operation, and testing procedures, and a list of material and equipment to be used.

g) Manufacturer's technical data containing complete information on new pipelines or conduits:

   i. Material composition, physical properties, inside diameter, and wall thickness.

   ii. Maximum tensile strength and corresponding maximum allowable pulling force.

   iii. Transporting, unloading, storing, and handling recommendations.

   iv. Repair.

   v. Fusion times and temperatures.

   vi. Minimum bend radius.

   vii. Recommended restraint method in structure.

   viii. New pipelines or conduits recovery requirements.

ix. Relaxation requirements.

h) Contingency plans for the following potential conditions:

i. Unforeseen obstructions causing burst stoppage.

ii. Deviation from required alignment and grade.

iii. Extended service disruption.

iv. Damage to the existing service connections and the replacement of new pipelines or conduits' structural integrity and methods of repair.

v. Damage to other existing Utilities.

vi. Soil heaving or settlement.

vii. Contaminated soil or water.

viii. Alignment passing through buried structures.

463.05 MATERIALS

463.05.01 Pipe Materials

Pipe type, class, pressure rating, and size shall be as specified in the Contract Documents.

463.05.02 Valves

Valve type, class, pressure rating, and size shall be as specified in the Contract Documents.

463.05.03 Fittings

Fittings shall be suitable for and compatible with the type, class, pressure rating, and size of pipe with which they are used.

463.05.04 Lubricant

Lubricant used to reduce friction, to maintain the annular space created by the pipe bursting head, and to allow the insertion of the new pipelines or conduits shall be non-toxic and biodegradable.

463.05.05 Tracer Wire

Type and number of tracer wires used shall be as specified in the Contract Documents.

463.06 EQUIPMENT

463.06.01 Pipe Bursting Head

The pipe bursting head shall be according to the manufacturer's specifications for head sizes recommended for various new pipelines or conduits diameters and types, as well as parameters associated with maximum allowable upsize percentages.

All types of interchangeable bursting heads corresponding to the different types of existing pipeline and conduit shall always be available on site to mitigate delays and downtime, as specified in the Contract Documents.

The appropriate type of bursting head shall be used for each different type of existing pipeline or conduit, or both, since the type of existing pipeline or conduit, or both, may vary within the section to be replaced by pipe bursting.

463.06.02 Pipe Bursting Power Source

The pipe bursting power source shall generate sufficient force to burst and compact the existing pipeline or conduit into the surrounding material.

463.06.03 Fusion Equipment

Fusion equipment, when used, shall be sized, and rated for the new pipelines or conduits. Fusion clamps shall be sized to clamp the new pipelines or conduits properly.

A weak link or breakaway connector shall be used to prevent excess pulling force from damaging the new pipelines or conduits. A load monitor on the pushing/pulling equipment shall be used to monitor, document, and report the pulling force applied.

463.07 CONSTRUCTION

463.07.01 General

The new pipelines or conduits shall be installed following the alignment and grade of the existing pipe and to the ovality specified in the Contract Documents.

The Contract Administrator shall be notified at least 48 hours prior to commencement of work.

463.07.02 Site Preparation

Site preparation shall be according to OPSS 490 and as specified herein.

The work site shall be graded or filled to provide a level working area for the pipe bursting equipment. No alterations beyond what is required for the pipe bursting operations shall be made. All activities shall be confined to designated work areas.

All existing water service shall be disconnected from the host watermain prior to the bursting process and reinstated after the successful testing and commissioning of the new watermain.

All existing crosses, tees, and valves shall be located, exposed, and disconnected prior to the bursting process.

463.07.03 Preservation and Protection of Existing Facilities

Preservation and protection of existing facilities shall be according to OPSS 491.

When specified in the Contract Documents, an existing facility shall be exposed to verify its horizontal and vertical location. The number of exposures required to monitor work progress shall be as specified in the Contract Documents.

When specified in the Contract Documents, any above-grade facilities shall be supported as required.

463.07.04 Transporting, Unloading, Storing, and Handling Materials

Manufacturer's recommendations for transporting, unloading, storing, and handling of materials shall be followed.

Pipe rollers, skates or other protective devices as approved by the Owner shall be used to eliminate dragging of the new pipelines or conduits pipe across the ground during pull-back operations, and to prevent any damage to the pipe on the edges of the pit. A sufficient number of rollers shall be used to prevent excess sagging of a pipe, and the rollers shall be of adequate size to fully support the weight of the new pipelines or conduits pipe.

The pipe shall not be dragged over the ground, and adequate rollers shall be used for both insertion and transportation of the pipe.

These pipe guide rollers shall help minimize drag forces of pipe-pulling through horizontally drilled or bored holes.

The ends of the pipe shall always stay capped while on site, to prevent the entry of contaminants into the pipe.

463.07.05 Trenching, Backfilling, and Compacting

Trenching, backfilling, and compacting for launch pits, pull pits, and other excavation locations shall be according to OPSS 401.

Launch pits and pull pits shall be sized to allow the use of the pipe bursting equipment and to allow the new pipelines or conduits to be installed such that the new pipelines or conduits manufacturer’s recommendations for new pipelines or conduits bending radius are not exceeded.

463.07.06 Support Systems

Support systems shall be according to OPSS 404.

463.07.07 Dewatering

Dewatering shall be according to OPSS 517.

463.07.08 Temporary Protection Systems

The construction of temporary protection systems shall be according to OPSS 539.

Where the stability, safety, or function of an existing roadway, railway, watercourse, other works, or proposed works may be impaired due to the method of operation, protection shall be provided. Protection may include sheathing, shoring, and piling where necessary to prevent damage to such works or proposed works.

463.07.09 Temporary Potable Water Supply Services

When specified in the Contract Documents, temporary potable water supply services shall be according to OPSS 493.

463.07.10 New Pipelines or Conduits By-Pass

When specified in the Contract Documents, during the execution of the work the flow within the existing pipeline or conduit shall be bypassed around the new pipelines or conduits being replaced and the continuity of service to each facility connected to the affected section of new pipelines or conduits shall be maintained. The pumps and by-pass lines shall be of adequate capacity and size to handle all flows.

463.07.11 Preparation of Existing Pipelines or Conduits and Structures

All existing crosses, tees, valves, and service connections shall be located, exposed, and disconnected prior to any pipe bursting operation.

Prior to pipe bursting, the inlets, outlets, and benching of existing structures shall be enlarged sufficiently for clearance of the pipe bursting head and the new pipelines or conduits. Enlargements shall be made neatly and be no greater than that required for their purpose. Size of the enlargements shall be sufficient to allow for restoration and sealing to the new pipelines or conduits.

Existing pipeline or conduit shall be cleared of obstructions (e.g., rocks and debris) or mechanical obstructions (e.g., repair sleeves, clamps, couplings, and intolerable deviations in grade or alignment) prior to pipe bursting.

463.07.12 New Pipelines or Conduits Joining

463.07.12.01 General

The new pipelines or conduits shall be joined according to the manufacturer's recommendations. The new

pipelines or conduits shall be assembled and joined at the site to provide a leak-proof joint.

When space and the Contract Documents permit, the length of the new pipelines or conduits to be pulled shall be joined as one length prior to the commencement of the pulling operation.

When used, fusion shall be performed by technicians trained in the use of the fusion equipment.

Joints shall be capable of withstanding the loading of the installation process. All joints shall be subject to acceptance by the Contract Administrator prior to insertion.

The following provisions for the fusion process shall be followed:

a) Each joint fusion shall be recorded and logged by an electronic monitoring device (e.g., data logger) affixed to the fusion machine.

b) The joined pipeline or conduit, or both, shall be installed in a manner so as not to exceed the manufacturer's recommended bend radius.

c) If the joined pipeline or conduit, or both are installed by pulling in tension then the recommended safe pulling force in accordance with the manufacturer shall not be exceeded.

d) Fusion machines shall meet the manufacturer's fusion specifications.

e) The fusion technician shall be fully trained, certified, and licensed in the use of the fusion equipment by an authorized representative of the fusion equipment manufacturer and the new pipelines or conduits manufacturer.

f) Qualifications shall be current as of the actual date of fusion performance on the project. Training records for qualified fusion technicians shall be made available to the Owner upon request.

463.07.12.02 Connection to New Pipelines or Conduits or Structures

New pipelines or conduits shall be allowed to recover from any induced stresses and strains before connection to new or existing pipeline or conduit or structures are made. New pipelines or conduits recovery time shall be according to the manufacturer's recommendations.

The new pipelines or conduits connection to the structure or to an existing pipeline or conduit shall be leak-proof.

463.07.12.03 Service Connections

Service connection work shall be as specified in the Contract Documents.

Service connection work shall not commence until the new pipelines or conduits has fully recovered.

463.07.13 New Pipelines or Conduits Installation

Installation procedures shall be according to the new pipelines or conduits manufacturer's guidelines. The new pipelines or conduits shall be protected from damage during the installation process.

Suitable guides shall be used to protect the new pipelines or conduits from damage at the insertion point and at any intermediate re-entry points.

The maximum axial/compression forces and bending moments shall not exceed tolerable limits of the new pipelines or conduits in order to avoid damaging the new pipelines or conduits or joints, or both.

Upon commencement of the bursting process, new pipelines or conduits insertion shall be continuous from the launch pit to the pull pit, except when approved by the Contract Administrator. A pushing machine may be used to assist insertion from the rear.

When specified in the Contract Documents, a weak link, breakaway connector, or load monitor shall be used to prevent excess pulling force from damaging the new pipelines or conduits.

463.07.14 Structures and Valves

When the new pipelines or conduits enters or exits an existing structure, the structure wall shall be restored as specified in the Contract Documents. Restoration shall securely locate and anchor the new pipelines or conduits in the wall and shall produce a leak-proof seal.

The existing structure's benching shall be restored according to the requirements of the new pipelines or conduits, any other incoming new pipelines or conduits, and as specified in the Contract Documents.

When new structures or valves are specified, they shall be installed according to OPSS 407 and OPSS 441, respectively.

463.07.15 Testing

Testing of the new pipelines or conduits joining and installation shall be as specified in the Contract Documents.

When specified in the Contract Documents, closed-circuit television (CCTV) inspection shall be completed on the new pipelines or conduits after installation.

463.07.16 Record Keeping

Fusion joint data shall be submitted as part of the As-Recorded information, as specified in the Contract Documents.

Verification record requirements of the alignment and grade of the installed new pipelines or conduits shall be as specified in the Contract Documents. A copy of the verification records shall be given to the Contract Administrator at the completion of the pipe bursting operations.

463.07.17 Closed-Circuit Television Inspection

CCTV inspection shall be according to OPSS 409.

463.07.18 Site Restoration

Site restoration shall be according to OPSS 492.

463.07.19 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

463.07.20 Environmental Protection and Contingency

Environmental protection requirements and mitigation measures shall be as specified in the Contract Documents.

463.07.21 Tracer Wire

Proper techniques shall be applied to safely pull all tracer wires during the bursting operation. Welding a hook to connect the tracer wires on to the bursting head shall be required.

463.08 QUALITY ASSURANCE

463.08.01 Acceptance Criteria

Acceptance criteria for the new pipelines or conduits installation shall be as specified in the Contract Documents.

463.09 MEASUREMENT FOR PAYMENT

463.09.01 Actual Measurement

463.09.01.01 New Pipelines or Conduits Installation by Pipe Bursting

Measurement for a new pipelines or conduits installation by pipe bursting shall be by length in metres along the horizontal centreline of the new pipelines or conduits between connecting points or, if there is no connecting point, to the end of the new pipelines or conduits. When the connecting point is a structure, measurement for a new pipelines or conduits installation shall be by length in metres to the centre of the structure.

The interchanging and use of multiple bursting heads shall be at no additional costs to the Owner.

All tasks related to locating, exposing, and disconnecting prior to bursting process shall be included in the unit price item for pipe bursting.

463.09.01.02 Service Connections

For measurement purposes, a count shall be made of the number of existing services that are disconnected from the existing pipeline or conduit and reconnected to the new pipelines or conduits.

463.09.02 Plan Quantity Measurements

When payment is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

463.10 BASIS OF PAYMENT

463.10.01 New Pipelines or Conduits Installation by Pipe Bursting, “Type, Diameter, and Use of New Pipelines or Conduits” - Item
New Pipelines or Conduits Bypass - Item
Service Connections - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

463.10.02 Closed-Circuit Television Inspection

When the Contract does not contain a separate tender item for CCTV inspection, the Contract price for the new pipelines or conduits Installation by Pipe Bursting item shall include full compensation for all labour, Equipment, and Material to do the work of CCTV inspection.

Appendix 463-A, November 2021
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

This specification was written to encompass the majority of pipe bursting operations for small and medium sized projects. However, the basic design considerations should always include properly planned entry and exit points, grade of existing host pipe, adjacent Utilities, and connection requirements.

The International Pipe Bursting Association (IPBA) normally assigns pipe bursting work to one of three classifications. These following classifications (January 2012 version) are intended for use as general guidelines when considering replacement of existing pipe by pipe bursting techniques. The classification should be determined based on the more stringent parameter in the table below.

IPBA Classification and Degree of Difficulty	Depth of Pipe m	Existing Pipe Diameter mm	New Pipe Diameter Options	Burst Length m	Original Trench Width	Soil Type
A - Minimal	< 3.65	- 50 - 300	Size on Size	0 - 100	Relatively wide trench compared to expander head outside diameter.	Compressible soils outside trench (loose sand, gravel, soft clay).
B - Moderate	> 3.66 to < 5.5	- 350 - 450	Single Upsize	- 100 - 150	Trench width less than 4" wider than the expander head outside diameter.	Moderately compressible soils outside trench (medium dense to dense sand, medium to stiff clay).
C - Comprehensive	> 5.6+	- 500 - 900	Double / Triple Upsize	- 150 - 300	Incompressible soils outside trench.	Constricted trench geometry (width less than or equal to outside diameter of bursting head).
D - Developmental						

The designer may consider a pre-qualification process to ensure that the Contractor(s) possess the required capabilities and qualifications to undertake the work required under the contract.

The designer should include the following in the Contract Documents:

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- Pipe type, class, pressure rating, and size. (463.05.01)

- Valve type, class, pressure rating, and size. (463.05.02)

- To ensure successful continuity of at least one tracer wire, post installation, consideration should be given towards the type and number of tracer wires to account for the various forces that the tracer wires may be subjected to (including, but not limited to burst pipe fragments, over burden materials, etc.). (463.05.05)

- Interchangeable bursting heads. (463.06.01)

- New pipelines or conduits ovality. (463.07.01)

- Preservation and protection of existing facilities. (463.07.03)

- Temporary potable water supply services. (463.07.09)

- New pipelines or conduits by-pass. (463.07.10)

- New pipelines or conduits joining. (463.07.12)

- Service connection work. (463.07.12.03)

- New pipelines or conduits installation. (463.07.13)

- Structures, valves, and benching restoration. (463.07.14)

- Testing of new pipelines or conduits joining and installation. (463.07.15)

- Verification record requirements. (463.07.16)

- Management of excess material. (463.07.19)

- Environmental protection and contingency. (463.07.20)

- Acceptance criteria. (463.08.01)

The designer should determine if the following are required and, if so, they should be specified in the Contract Documents:

- Consideration should be given to adjusting the submission timeline to be shorter or longer, as needed. When deciding, consider including provisions for time required by the Contract Administrator for reviewing the submission and providing feedback to the Contractor in a timely fashion, prior to commencement of pipe bursting operations. (463.04.01)

- Exposing existing facilities. (463.07.03)

- Use of temporary potable water supply services. (463.07.09)

- New pipelines or conduits by-pass. (463.07.10)

- Joining and pulling new pipelines or conduits as one length. (463.07.12.01)

- Use of a weak link, breakaway connector, or load monitor. (463.07.13)

- Wall restoration. (463.07.14)

- Completion of a CCTV inspection. (463.07.15)

The designer should give consideration, in consultation with the pipe manufacturer, to minimum allowable new pipelines or conduits bending radii commensurate with the pipeline's strength.

The designer should give special consideration to the required grades at the entry and exit points. The designer may undertake a CCTV inspection and location analysis prior to pipe bursting to review the existing line and grade to determine if deviations are acceptable.

New pipelines or conduits upsizing by using a pipe bursting technique may induce stresses in the surrounding soil resulting in potential damage to nearby Utilities and foundations. The degree of distortion on the zone of influence is a function of the degree of upsizing, the pipe material of a nearby Utility, the location of nearby Utilities in relation to the pipe burst pipe, and the soil conditions. The designer may consider exposure of critical services by non-destructive methods to monitor the pipe bursting progress and impacts.

The designer should consider the need for new pipelines or conduits bypass, temporary potable water supply services, or temporary flow stoppage or blockage with inflatable plugs during the pipe bursting operation. The designer may require that during the execution of the work, the flow shall be bypassed around the new pipelines or conduits being replaced and the continuity of service to each facility connected to the affected section of new pipelines or conduits be maintained. The designer should consider what should be done if there is an extended service disruption.

For certain new pipelines or conduits installations, the designer may consider the requirement of a weak link, breakaway connector, or load monitor to prevent excess pulling force from damaging the new pipelines or conduits.

The designer should consider the type of interface and the degree of continuity between the new pipelines or conduits and the existing structure to ensure appropriate anchoring and seals in order to prevent new pipelines or conduits retraction or inadvertent leaks to the new system.

The designer may specify the completion of a CCTV inspection of the new pipelines or conduits after installation, particularly when grade thresholds are critical. In smaller diameter new pipelines or conduits installations when the designer elects to complete a CCTV survey, the designer may wish to specify a lighter interior colour of the new pipelines or conduits installation, if available.

Testing of new pipelines or conduits joining and installation may include hydrostatic, air, BACT-T, etc.

Verification record requirements may include such information as reporting information available from the pipe bursting machine, daylighting, installation of tracer wire with the new pipelines or conduits, the use of acoustic or magnetic locating equipment, etc.

Acceptance criteria requirements may include such considerations as successful bursting operation from entry to pull back location; CCTV inspection, removal of extra coupon pipe length from the pull back pit to view for stresses, grade verification, etc.

The designer may consider including a process regarding payment for failed pipe bursting attempts in the Contract Documents.

The tender item description for new pipelines or conduits Installation by Pipe Bursting should include reference to one or more of the attributes shown (i.e., type of new pipelines or conduits, diameter of new pipelines or conduits, and use of new pipelines or conduits) to be complete.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

CONSTRUCTION SPECIFICATION FOR SEWER PIPELINE AND CULVERT REHABILITATION BY PVC FOLD AND FORM LINER

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465-A **Commentary**

465.01 SCOPE

This specification covers the requirements for the rehabilitation of sewer pipelines and culverts by the installation of a continuous and tight-fitting PVC Fold and Form Liner (FFL) for structural or non-structural applications.

465.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be as specified in the Contract Documents.

465.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

465.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standards Specifications, Construction

OPSS 401	Trenching, Backfilling, and Compacting
OPSS 404	Support Systems
OPSS 409	Closed-Circuit Television Inspection of Pipelines

ASTM International

D 638-08	Standard Test Method for Tensile Properties of Plastics
D 790-07e1	Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
D 2990-09	Standard Test Methods for Tensile, Compressive, and Flexural Creep and Creep-Rupture of Plastics
F1871-11	Folded/Formed Poly (Vinyl Chloride) Pipe Type A for Existing Sewer and Conduit Rehabilitation
F1504-14	Standard Specification for Folded Poly (Vinyl Chloride) (PVC) Pipe for Existing Sewer and Conduit Rehabilitation
F1867-06	Standard Practice for Installation of Folded/Formed Poly (Vinyl Chloride) (PVC) Pipe Type A for Existing Sewer and Conduit Rehabilitation
F1947-10	Standard Practice for Installation of Folded Poly (Vinyl Chloride) (PVC) Pipe into Existing Sewers and Conduits

CSA Standards

S6-14	Canadian Highway Bridge Code

465.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Non-Structural Liner means a liner that does require assistance from the host pipe to support external loads.

PVC Fold and Form Lining means the rehabilitation of gravity sewers and culverts by installation of a PVC Fold and Form Liner system within an existing pipe.

Structural Liner means a liner that does not require assistance from the host pipe to support external loads.

465.04 DESIGN AND SUBMISSION REQUIREMENTS

465.04.01 Design Requirements

The engineering design shall be in accordance with ASTM F 1867 or ASTM F1947 with the following criteria:

a) Design conditions:

   i. PVC Fold and Form design shall assume partially or fully deteriorated condition of the original pipe.
   ii. PVC Fold and Form design shall assume no bonding to the original pipe wall.

b) Parameters for design:

   i. Minimum design life of 50 years.
   ii. Safety factor of 2 on external loads.
   iii. Groundwater depth is full soil depth, unless otherwise known.
   iv. Soil modulus of 6.9 MPa, unless otherwise known.
   v. Soil density of 2140 kg/m3, unless otherwise known.
   vi. Load as per S6-14 of 166.6 kN.
   vii. Minimum ovality of 3% unless otherwise known.
   viii. Minimum depth of 4m to invert unless otherwise known.
   ix. Maximum nominal pipe size of 900mm.

Pipe installation forces or pressures shall be limited so as not to stretch the tube longitudinally by more than 5% of the original length. The flexible liner shall be fabricated to a size that neatly fits the internal circumference of the host pipe. Allowance shall be made for circumferential stretching during insertion.

465.04.02 Submission Requirements

Working Drawings for the lining shall be submitted to the Contract Administrator for approval, minimum of 14 Days prior to installation. The design flow calculations shall show technical assumptions, identify the design formulas used, and show minimum finished inside diameter. The ovality condition used in the calculations shall be within manufacturer's tolerance for the liner product.

Working Drawings shall graphically illustrate the installation conditions (including, depth of pipeline, water table depth, pipe invert and crown, and full details of the parameters used).

The design submission shall bear the seal and signature of an Engineer.

The following information shall be submitted to the Contract Administrator, minimum of 7 Days prior to commencing Work:

a) A work plan outlining the schedule, procedures, and work site.

b) A list of personnel, including backup personnel, with their qualifications and experience.

c) A vehicle and pedestrian traffic control plan.

d) Safety plan, including the company safety manual and emergency procedures.

e) Product by-pass or temporary supply system plans, including methods, with a list of equipment to be used.

f) Manufacturer's technical data containing complete information on:

   i. Material composition, physical properties, and dimensions of the new product.
   ii. Recommendations for transportation, handling, and storage.
   iii. Repair of product damaged during installation.
   iv. Installation and connection details.
   v. Processing pressures.
   vi. Product post-processing procedures listing the temperature and duration, including cool down time for the product.
   vii. Temporary insertion load (pulling force).
   viii. Procedure for filling voids for the structural integrity of the liner system.

g) Contingency plans for the following potential conditions:

   i. Damage to the existing service connections.
   ii. Improper placement of the PVC Fold and Form Liner.
   iii. Damage to the host pipe.
   iv. The liner’s failure to achieve structural integrity.

h) A sample letter to residents impacted by the work shall be submitted to the Contract Administrator for approval, minimum of 14 Days prior to commencing the work.

465.05 MATERIALS

465.05.01 Liner

The PVC Fold and Form Liner material shall be 3rd party certified to ASTM F1871 or ASTM F1504 by a certification agency accredited by the Standards Council of Canada, and shall have the following minimum physical properties:

a) Flexural strength of 28 MPa according to ASTM D790.

b) Flexural modulus of 1,000 MPa according to ASTM D790.

c) Tensile strength of 25 MPa according to ASTM D638.

d) 50-year creep reduction as per ASTM D2990.

465.07 CONSTRUCTION

465.07.01 General

The Contract Administrator shall be notified, minimum of 48 hours in advance of starting work.

The exact size and length of all existing pipes to be rehabilitated shall be confirmed prior to installation. All required equipment shall be on-site and in satisfactory working order prior to commencing the installation of a lining section.

Work shall progress and continue as required to minimize downtime on pipelines and out-of-service periods on laterals.

At least 7 Days prior to any interruption in service, all residents and businesses who may be affected by the rehabilitation process about the nature, duration, and expected date of any interruption in service and the contact information of the Contractor, shall be advised in writing. In addition, all affected residents and businesses shall be notified of the specific time of the disruption to their service at least 24 hours in advance and shall endeavour to minimize their inconvenience. During the course of the rehabilitation and any associated service interruption, the residents shall be kept regularly informed regarding any matters that affect them.

Testing shall be carried out as specified in the Contract Documents to confirm that each service connection is live.

465.07.02 Preservation and Protection of Existing Facilities

Preservation and protection of existing facilities shall be according to OPSS 491.

465.07.03 Transporting, Unloading, Storing, and Handling Materials

Manufacturer's recommendations for transporting, unloading, storing, and handling of materials shall be followed.

465.07.04 Trenching, Backfilling, and Compacting

Trenching, backfilling, and compacting for any access pits shall be according to OPSS 401.

465.07.05 Support Systems

Support systems shall be according to OPSS 404.

465.07.06 Dewatering

Dewatering shall be according to OPSS 517.

465.07.07 Temporary Protection Systems

The construction of temporary protection systems shall be according to OPSS 539.

Where the stability, safety, or function of an existing roadway, railway, watercourse, other works, or proposed works may be impaired due to the method of operation, protection shall be provided. Protection may include sheathing, shoring, and piling where necessary to prevent damage to such works or proposed works.

465.07.08 Temporary Service

465.07.08.01 Sewer Lining, Sewer Flow By-Pass Plan

When specified in the Contract Documents, during the execution of the work, the sewer flow shall be by-passed around the pipeline being relined.

Pumps and by-pass lines shall be of adequate capacity and size to handle all flows.

When interruption of sewer line flows is necessary to properly conduct the inspection and rehabilitation operations, acceptable methods of flow control shall be used. Make all necessary arrangements with the owners, property managers, and residents of each building. All property owners or tenants or both shall be contacted to coordinate the repair work to the sewer and minimize any impact to the residents and businesses.

When specified in the Contract Documents, during the inspection and rehabilitation, sewer flows shall be shut off in order to enable proper inspection of the pipe invert. After the work is completed, flows shall be restored to normal.

On all liner installation dates, a primary and stand-by by-pass pump and pump power supply shall be maintained on-site. Sufficient power supply and hoses shall be on-site in order to allow the pump to discharge into the next downstream sewer section. The stand-by by-pass pump and power supply shall be of an equal or better capability than the primary by-pass pump and power supply. No by-pass pumps or related equipment shall be disconnected or removed from the sewer or work site until after all service connections have been reinstated and the Contractor has recorded the post-installation video.

All by-pass pumping shall be in place and operational prior to the final pre-installation inspection. All by-pass pumping capacities and configurations shall be approved by the Contract Administrator prior to the actual liner installation date. When specified in the Contract Documents, all by-pass pumps and related equipment shall be silenced equipment or contained within an acceptable sound reduction structure.

465.07.09 Preparation of Existing Pipeline

A pre-installation inspection shall be completed in the presence of the Contract Administrator prior to the commencement of the pipeline rehabilitation.

The existing pipeline to be rehabilitated shall be prepared in accordance with the manufacturer's requirements for PVC Fold and Form Liner installation. Debris, grease, and other deposits shall be removed from the pipeline. Any obstructions remaining after flushing and cleaning shall be removed without damaging the existing pipeline walls. All roots that interfere with the lining installation shall be removed. Any calcite build-up in the existing pipeline that interferes with the PVC Fold and Form Liner shall be removed by means that do not damage the existing pipeline walls. Protrusions from deposits such as calcite shall not exceed the maximum allowable values as specified in ASTM F 1216.

Existing protruding service laterals that interfere with the installation or performance of the liner shall be removed without damage to the lateral or the pipeline wall. Flail type equipment is not permitted for the removal of protruding laterals.

A screen shall be installed in the downstream maintenance hole in order to catch any material, including cut outs from service connection openings that may migrate downstream. Such material shall be removed from the maintenance hole.

If the pre-installation inspection reveals an obstruction such as a protruding service connection, a dropped joint, or a collapse that prevents the lining process and the obstruction cannot be removed by conventional sewer cleaning equipment, then a trenchless technique shall be attempted to remove or

repair the obstruction. Any necessary excavation shall be approved in writing by the Contract Administrator prior to the commencement of such excavation.

When the filling of voids is necessary to ensure structural integrity of the pipeline and to prevent bridging of the liner, a detailed procedure, outlining the process and materials to be used to fill the voids, shall be submitted to the Contract Administrator for approval prior to commencement of the work.

465.07.10 Access Pits

When possible, existing maintenance holes shall be used as access pit locations. Access pit locations shall be approved by the Contract Administrator prior to the beginning of construction.

465.07.11 Closed-Circuit Television (CCTV) Inspection

CCTV inspection shall be according to OPSS 409.

A Post Preparation Video Inspection and a Post-Lining Final Video Inspection of Complete Rehabilitation shall be completed for each pipeline section.

465.07.11.01 Post Preparation Video Inspection

After completion of the preparation of a pipeline section, a CCTV inspection of the full length of the pipeline section shall be performed and a report submitted to the Contract Administrator. Prior to the delivery of the 24-hour service interruption notice and commencement of any lining installation taking place, approval of the prepared section shall be obtained from the Contract Administrator.

465.07.11.02 Post-Lining Final Video Inspection of Complete Rehabilitation

After completion of all work required for the lining of the pipeline section, a CCTV inspection of the full length of the pipeline section shall be performed and a report submitted to the Contract Administrator for approval of the work. The final video recording shall be submitted to the Contract Administrator for approval immediately upon completion of the work, but no more than 48 hours after the lining installation in each section. The inside wall of the access point at each end of the pipeline section shall be clearly visible on the inspection video.

465.07.12 PVC Fold and Form Lining Installation

The installation of the PVC Fold and Form Liner shall be according to the manufacturer's recommendations.

Before installation begins, the manufacturer's recommendations shall be obtained for the minimum pressure required to hold the tube tight against the existing pipes and the maximum allowable pressure, so as not to damage the existing pipe. Once the installation has started, pressure shall be maintained between the minimum and maximum pressures until the installation has been completed.

The existing pipes shall be dewatered prior to installation.

465.07.13 Processing

The PVC Fold and Form Liner installation shall be according to ASTM F1867 or ASTM F1947. Qualified personnel shall monitor the processing phase and maintain written records, including boiler monitor graphs, water temperatures and lining temperatures throughout the curing process. These records shall be made available to the Contract Administrator upon request.

The PVC Fold and Form Liner shall be inserted and processed in accordance with the manufacturer's parameters and procedures.

Liner external surface temperatures at access points shall be measured.

The time required for the processing shall be determined by the temperature monitoring and shall be adjusted to suit the lengths, diameter, thickness, field conditions, and ambient temperature applicable to each pipe lining section.

465.07.14 Cool-Down

The PVC Fold and Form Liner shall be cooled to a temperature below 38 °C before relieving the pressure. Cool-down may be accomplished by the introduction of air into the PVC Fold and Form Liner to replace steam used during processing.

465.07.15 Inflation Plug Removal

Once processing and cool-down have been completed, the inflation plugs shall be removed.

465.07.16 Liner Termination

The liner termination at and through sections shall be neat and free of obstructions. If the liner termination fails to make a watertight seal with the existing pipe, a seal shall be applied at this point. The sealing process shall use a material compatible with the liner pipe.

In the case where the liner is installed through an existing maintenance hole, the liner shall be trimmed neatly and parged at the interface between the liner and any other existing sewers or service connections entering into the maintenance hole.

465.07.17 Testing

When specified in the Contract Documents, testing shall be in accordance with the requirements of ASTM F1867 or ASTM F1947. A sample shall be taken from the processed liner obvert at an access point, sufficient in size to meet the requirements of ASTM D 790. The testing of the sample shall be done by an independent testing laboratory approved by the Contract Administrator.

465.07.17.01 Finished Liner

When required, a cylindrical sample of the lining of at least 200 mm in length, for each section of lining, shall be provided to the Contract Administrator. The sample shall be taken from lining that extends into an access point on the section. A suitable form shall be used to create the sample so that the conditions of making the sample are as close as possible to the installation and processing conditions for the corresponding section of pipe being lined.

PVC Fold and Form samples shall be prepared and physical properties tested in accordance with ASTM F1867 or ASTM F1947.

Visual inspection of the PVC Fold and Form liner shall be in accordance with ASTM F1867 or ASTM F1947.

465.07.18 Service Connections and Lateral Reinstatements

Service connection and lateral reinstatement shall be made internally with appropriate remotely operated equipment. Excavation of connections or laterals shall not be allowed. Restored connection or lateral openings shall be cut neatly to full size without over-cutting. Cuts shall be smooth and without residual material left around the opening. Ragged edges or attached material shall not be permitted.

When sewer lateral flow has been interrupted, reinstatement of the lateral shall proceed urgently and with all possible speed to restore lateral flow. Laterals may be reinstated using an initial opening sufficient to restore flow, followed by completion to full reinstatement of 100% open within 24 hours.

465.07.19 Site Restoration

Site restoration shall be according to OPSS 492.

465.07.20 Management of Excess Material

Management of excess material shall be as specified in the Contract Documents.

465.09 MEASUREMENT FOR PAYMENT

465.09.01 Actual Measurement

465.09.01.01 Product Installation

Measurement for a product installation shall be by length in metres along the horizontal centreline of the product between connecting points or, if there is no connecting point, to the end of the product.

When the connecting point is a structure, measurement for a product installation shall be in metres to the centre of the structure.

465.09.01.02 Lateral Reinstatement

For measurement purposes, a count shall be made of the number of laterals reinstated.

465.09.02 Plan Quantity Measurement

When payment is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

465.10 BASIS OF PAYMENT

465.10.01 *Product Installation, "type, diameter, or use of product" – Item*
Lateral Reinstatement - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

The control of flow for sewers shall be done.

Any extraction of tools or equipment, including extraction by excavation, shall be done at no extra cost to the Owner.

465.10.02 Closed-Circuit Television Inspection

When the Contract does not contain a separate tender item for CCTV inspection, the Contract price for product installation shall include full compensation for all labour, equipment, and material to do the work of CCTV Inspection.

Appendix 465-A, November 2018
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Service connection testing. (465.07.01)

- Sewer lining, by-pass of flow for sewers. (465.07.08.01)

- Sound reduction. (465.07.08.01)

- Maximum allowable values for protrusions. (465.07.09)

- Costs associated with the filling of identified voids (465.10.01)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

CONSTRUCTION SPECIFICATION FOR SITE PREPARATION FOR PIPELINES, UTILITIES, AND ASSOCIATED STRUCTURES

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490.06 **EQUIPMENT - Not Used**

490.07 **CONSTRUCTION**

490.08 **QUALITY ASSURANCE - Not Used**

490.09 **MEASUREMENT FOR PAYMENT - Not Used**

490.10 **BASIS OF PAYMENT**

APPENDICES

490-A **Commentary**

490.01 SCOPE

This specification covers the requirements of site preparation for the installation of sanitary and storm pipe sewers, pipe culverts and end sections, forcemains and associated appurtenances, watermains and associated appurtenances, and other underground Utilities; maintenance holes, catch basins, ditch inlets, or valve chambers; and any other specified subsurface construction.

490.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be as specified in the Contract Documents.

490.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

490.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 201	Clearing, Close Cut Clearing, Grubbing, and Removal of Surface and Piled Boulders
OPSS 206	Grading
OPSS 412	Sewage Forcemain Installation in Open Cut
OPSS 441	Watermain Installation in Open Cut
OPSS 703	Permanent Small Signs and Support Systems
OPSS 706	Traffic Control Signing
OPSS 801	Protection of Trees
OPSS 802	Topsoil
OPSS 805	Temporary Erosion and Sediment Control Measures

490.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Associated Appurtenances means as defined in OPSS 412 for a sewer system, and OPSS 441 for a watermain.

490.07 CONSTRUCTION

490.07.01 General

Site preparatory work shall be performed prior to the installation of the pipelines, Utilities, and associated structures.

490.07.02 Removal of Existing Signing

Removal of existing signing for temporary conditions shall be according to OPSS 706. Replacement of existing signing for permanent conditions shall be according to OPSS 703.

490.07.03 Clearing and Grubbing

Clearing and grubbing and related work shall be according to OPSS 201.

490.07.04 Shrub and Tree Relocation

Shrubs and trees to be relocated shall be protected according to OPSS 801 in their original and final locations.

Shrub and tree relocation shall be as specified in the Contract Documents.

490.07.05 Tree Protection and Pruning

Tree protection and pruning shall be according to OPSS 801.

490.07.06 Stripping and Stockpiling Topsoil

Stripping of topsoil shall be according to OPSS 206. Topsoil shall be removed carefully in the Work Areas and shall not be mixed with subsoil or other materials.

Stockpiling of topsoil shall be according to OPSS 802 and as specified in the Contract Documents. Topsoil shall not be placed in or near tree stands, along flood plains, and in areas containing natural wildlife habitats. Perimeter drainage ditches shall be constructed to intercept and divert run-off to adjacent settling ponds. Temporary erosion and sediment control measures shall be according to OPSS 805, or by condition of any applicable permit, or as specified in Contract Documents. Stockpiles shall be protected to ensure minimum environmental interference.

490.07.07 Removal of Fences and Guide Rails

Property owners or occupants shall be given at least 24 hours notice in advance of dismantling fences. Fences and guide rails shall be dismantled, where necessary. All components that are broken, bent, or damaged as a result of the operation shall be removed from the site and replaced with new components. All reusable components shall be stored and protected.

490.07.08 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

490.10 BASIS OF PAYMENT

Payment at the Contract price for the appropriate tender items for the installation of sanitary and storm pipe sewers, pipe culverts and end sections, forcemains and associated appurtenances, watermains and associated appurtenances, and other underground Utilities; maintenance holes, catch basins, ditch inlets, or valve chambers; and any other specified subsurface construction shall be full compensation for all labour, Equipment, and Material to do the work of site preparation.

When the Contract contains separate items for work required by this specification, payment shall be at the Contract prices and according to the specifications for such work.

Appendix 490-A, November 2020
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the shrub and tree relocation and planting requirements in the Contract Documents. (490.07.04)

The designer may choose to specify a specific location for stockpiled topsoil in the Contract Documents. (490.07.06)

Temporary erosion and sediment control measures. (490.07.06)

If separate items are required to cover the various components of site preparation, they should be included in the Contract Documents.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

Note: The MUNI implemented in November 2017 replaces OPSS 491 COMMON, November 2010 with no technical content changes.

CONSTRUCTION SPECIFICATION FOR PRESERVATION, PROTECTION, AND RECONSTRUCTION OF EXISTING FACILITIES

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491.07 **CONSTRUCTION**

491.08 **QUALITY ASSURANCE - Not Used**

491.09 **MEASUREMENT FOR PAYMENT - Not Used**

491.10 **BASIS OF PAYMENT**

APPENDICES

491-A **Commentary**

491.01 SCOPE

This specification covers the requirements of preservation, protection, replacement, and reconstruction of existing services and structures during the installation or removal of sanitary and storm pipe sewers, pipe culverts and end sections, forcemains and associated appurtenances, watermains and associated appurtenances, and other underground Utilities; maintenance holes, catch basins, ditch inlets, or valve chambers; and any other specified subsurface construction.

491.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be as specified in the Contract Documents.

491.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

491.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 412 Sewage Forcemain Installation in Open Cut
OPSS 441 Watermain Installation in Open Cut

491.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Associated Appurtenances means as defined in OPSS 412 and OPSS 441.

491.07 CONSTRUCTION

491.07.01 General

The requirements and regulations of road authorities, Utility companies, and railway companies shall be adhered to at all times.

491.07.02 Notification

All road authorities, Utility companies, and railway companies shall be notified in writing at least 48 hours before approaching their facilities or entering their rights-of-way.

All owners of underground services shall be requested to locate, stake, and clearly mark in the field all underground services which are located on or near the line of the proposed work. Certificates shall be obtained from all owners of underground services having facilities in the area of the proposed work certifying that their facilities have been marked to confirm the Utility location.

Necessary arrangements shall be made with railway companies for the support and protection of their tracks.

491.07.03 Existing Services and Structures

All water or gas mains, sewers or drains, conduits, cables, service pipes, sidewalks, curbs, and all other structures or property in the vicinity of the work, whether above or underground shall be sustained in place and protected from damage. All water and gas service and flow in all sewers, drains, house or inlet connections, and all watercourses encountered during the progress of the work shall be maintained.

Excavation shall be performed with care to expose buried pipes, cables, conduits, and structures whenever trenching operations approach the indicated location of buried services.

If any Utility is broken or damaged, the Utility company shall be immediately notified.

Access to fire hydrants and water and gas valves shall be maintained at all times to the satisfaction of the local authority.

491.07.04 Reconstruction of Existing Facilities

Where an existing Utility is within the limits of or crosses an excavation and cannot be sustained in place, the existing facility shall be removed, realigned, relocated, or replaced as directed in writing by the Contract Administrator. All materials comprising the Utility shall be handled with care, cleaned, salvaged, and inspected before reconstruction commences.

491.07.05 Contamination

The contents of any sewer, drain, or inlet connection shall not be allowed to flow into an excavation.

All offensive matter shall be removed from the proximity of the work.

491.07.06 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

491.10 BASIS OF PAYMENT

Payment at the Contract price for the appropriate tender items for the installation of sanitary and storm pipe sewers, pipe culverts and end sections, forcemains and associated appurtenances, watermains and

associated appurtenances, and other underground Utilities; maintenance holes, catch basins, ditch inlets or valve chambers; and any other specified subsurface construction, shall be full compensation for all labour, Equipment, and Material to do the work of the preservation, protection, or reconstruction of existing facilities.

When the Contract contains separate items for work required by this specification, payment shall be at the Contract prices and according to the specifications for such work.

Appendix 491-A, November 2017
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

CONSTRUCTION SPECIFICATION FOR SITE RESTORATION FOLLOWING INSTALLATION OF PIPELINES, UTILITIES, AND ASSOCIATED STRUCTURES

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492.06 **EQUIPMENT - Not Used**

492.07 **CONSTRUCTION**

492.08 **QUALITY ASSURANCE - Not Used**

492.09 **MEASUREMENT FOR PAYMENT - Not Used**

492.10 **BASIS OF PAYMENT**

APPENDICES

492-A **Commentary**

492.01 SCOPE

This specification covers the requirements for the restoration of a site following installation of sanitary and storm pipe sewers, pipe culverts and end sections, forcemains and associated appurtenances, watermains and associated appurtenances, and other underground utilities; maintenance holes, catch basins, ditch inlets, or valve chambers; and any other specified subsurface construction.

492.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be as specified in the Contract Documents.

492.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

492.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 206	Grading
OPSS 304	Single and Double Surface Treatment
OPSS 310	Hot Mix Asphalt
OPSS 313	Hot Mix Asphalt - End Result
OPSS 314	Untreated Granular, Subbase, Base, Surface Shoulder, and Stockpiling
OPSS 350	Concrete Pavement and Concrete Base
OPSS 351	Concrete Sidewalk
OPSS 353	Concrete Curb and Gutter Systems
OPSS 412	Sewage Forcemain Installation in Open Cut
OPSS 441	Watermain Installation in Open Cut
OPSS 490	Site Preparation for Pipelines, Utilities, and Associated Structures
OPSS 721	Steel Beam Guide Rail and Cable Guide Rail
OPSS 771	Standard Highway Fence
OPSS 772	Chain-Link Fence
OPSS 802	Topsoil
OPSS 803	Sodding
OPSS 804	Seed and Cover

Ontario Provincial Standard Specification, Material

OPSS 1010	Aggregates - Base, Subbase, Select Subgrade, and Backfill Material
OPSS 1540	Standard Highway Fence Components
OPSS 1541	Chain-Link Fence Components
OPSS 1601	Wood - Material, Preservative Treatment, and Shop Fabrication

Canadian General Standards Board (CGSB)

138.2-2019	Steel Framework for Chain Link Fence

492.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Associated Appurtenances means as defined in OPSS 412 and OPSS 441.

492.05 MATERIALS

492.05.01 Granular Materials

Granular materials shall be according to OPSS 1010.

492.05.02 Barbed Wire

Barbed wire shall be according to CAN/CGSB-138.2.

492.05.03 Electric Fence Wire

Electric fence wire shall be 2 mm diameter hot dipped galvanized wire.

492.05.04 Wood Fence

Wood fence material shall be according to OPSS 1601.

492.05.04.01 Board or Split Rail Fence

Posts and boards shall be the same size and type as used in the original fence.

Rails shall be split cedar in good condition and of adequate lengths to build either a straight or snake fence.

492.05.04.02 Wood Braces for Wire Fence

Diagonal wood braces shall be according to OPSS 1540.

492.05.05 Highway Fence

Highway fence material shall be according to OPSS 1540.

492.05.06 Steel Posts

Steel posts shall be according to OPSS 1540.

492.05.07 Chain-Link Fence

Chain-link fence material shall be according to OPSS 1541.

492.05.08 Gates

Gates shall be fabricated from material suitable to the fence on either side of the gate opening. Material for highway fence gates shall be according to OPSS 1540. Material for chain-link fence gates shall be according to OPSS 1541.

492.05.09 Guide Rail

Guide rail material shall be according to OPSS 721.

492.05.10 Concrete

Concrete for sidewalks shall be according to OPSS 351.

Concrete for curb and gutter shall be according to OPSS 353.

492.07 CONSTRUCTION

492.07.01 General

All disturbed areas shall be restored to an equivalent or better condition than existed prior to the commencement of construction.

492.07.02 Grading

Rough grading shall be performed to the levels, grades, and contours as specified in the Contract Documents allowing for the placement of surface materials. Soil shall not be disturbed within the drip line of trees and shrubs during grading.

Final grading shall be performed to the lines and elevations specified in the Contract Documents. The final grading shall be according to OPSS 206.

492.07.03 Roadway Restoration

The restoration of the roadway shall be scheduled to follow closely behind trench backfilling. The roadway shall be made and maintained safe for the passage of vehicular and pedestrian traffic after completion of backfilling and until permanent restoration takes place, as specified in the Contract Documents.

Granular subbase and base courses of the type specified in the Contract Documents shall be placed on the prepared subgrade to the dimensions specified in the Contract Documents and shall be according to OPSS 314.

The surface course of the type specified in the Contract Documents shall be placed on the prepared base course to the dimensions specified in the Contract Documents according to as follows:

a) Asphalt pavement shall be according to OPSS 310 or OPSS 313 as specified in the Contract Documents.

b) Concrete paving shall be not less than 150 mm in thickness and shall be according to OPSS 350.

c) Gravel surface courses shall be according to OPSS 314.

d) Surface treatment shall be according to OPSS 304.

492.07.04 Fences and Guide Rails

Fences and guide rails shall be restored with the same type of fence or guide rail that existed prior to construction along the lines and levels specified in the Contract Documents. A maximum clearance of 150 mm from ground level shall be maintained at any point along the fence line.

The erection of highway fence shall be according to OPSS 771.

The erection of chain-link fence shall be according to OPSS 772.

Posts for fences other than highway and chain-link fences shall be installed to the spacing that existed prior to construction.

Gates shall be installed at the same location and height as the gates that existed prior to construction. Gate size shall be according to the dimensions of the gate that existed prior to construction. Gates shall be secured with fittings to match the fence complete with latches, hinges, stops, and all necessary fittings.

Colour and finish material of the restored fence shall match the existing colour scheme and finish material. Where required, two coats of finish material shall be applied.

The construction of guide rails shall be according to OPSS 721.

492.07.05 Topsoil

Topsoil shall be placed after final grading operations have been completed and immediately prior to seeding or sodding operations. Topsoil shall be obtained from stockpiles prepared according to OPSS 490 or, if the required quantity is not obtainable from stockpiles, then the required topsoil shall be imported.

The quality of the topsoil and the construction methods for placing topsoil shall be according to OPSS 802. Stockpile sites within or adjacent to the Contract limits shall be restored to the original condition or to a condition acceptable to the Contract Administrator.

492.07.06 Shrub and Tree Replanting

Shrubs and trees shall be replanted as specified in the Contract Documents.

492.07.07 Sodding and Seeding

Lawns and grassed areas shall be sodded or seeded and covered as specified in the Contract Documents.

Sodding shall be according to OPSS 803.

Seeding and cover shall be according to OPSS 804.

492.07.08 Sidewalk and Concrete Curb and Gutter Systems

Concrete sidewalk shall be placed according to OPSS 351. Alignment and dimensions shall match existing sidewalk on either end of the restored sidewalk. Damaged sections of any sidewalk slab shall be removed and replaced to the nearest joint on either end of the damaged section.

Concrete curb and gutter systems shall be placed according to OPSS 353. Alignment and dimensions shall match the existing curb and gutter systems on either side of the restored curb and gutter. Damaged sections of curb and gutter shall be removed and replaced to the nearest joint or neat saw cut.

Placement of Granular A shall be according to OPSS 314 with a minimum depth of 100 mm as a base for the curb and gutter and sidewalk.

492.07.09 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

492.10 BASIS OF PAYMENT

Payment at the Contract price for the appropriate tender items for the installation of sanitary and storm pipe sewers, pipe culverts and end sections, forcemains and associated appurtenances, watermains and associated appurtenances, and other underground utilities; maintenance holes, catch basins, ditch inlets, or valve chambers; and any other specified subsurface construction shall be full compensation for all labour, Equipment, and Material to do the work of site restoration.

When the Contract contains separate items for work required by this specification, payment shall be at the Contract prices and according to the specifications for such work.

Appendix 492-A, November 2020
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Levels, grades, and contours for rough grading. (492.07.02)

- Lines and elevations for final grading. (492.07.02)

- Requirements for temporary roadway. (492.07.03)

- Type of granular subbase and base courses and surface course. (492.07.03)

- Dimensions of the granular subbase and base courses and surface course. (492.07.03)

- OPSS 310 or OPSS 313 for asphalt pavement. (492.07.03, a))

- Lines and levels for restoration of fences and guide rails. (492.07.04)

- Replanting of shrubs and trees. (492.07.06)

- Sodding or seeding and cover of lawns and grassed areas. (492.07.07)

Designer should determine if the Contract is to have separate items to cover the various components of site restoration or if the items for the installation of pipelines, utilities, and their associated structures will be all inclusive to cover the work. If separate items are desired, they should then be included in the Contract Documents along with the details of the work.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 912.101 to 912.532	Guide Rail System, Steel Beam
OPSD 913.101 to 913.130	Guide Rail System, Cable
OPSD 971.101 to 971.102	Fence, Highway Installation
OPSD 972.101 to 972.131	Fence, Chain-Link

CONSTRUCTION SPECIFICATION FOR TEMPORARY POTABLE WATER SUPPLY SERVICES

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493.07 **CONSTRUCTION**

493.08 **QUALITY ASSURANCE - Not Used**

493.09 **MEASUREMENT FOR PAYMENT - Not Used**

493.10 **BASIS OF PAYMENT**

APPENDICES

493-A **Commentary**

493.01 SCOPE

This specification covers the requirements for the installation of temporary watermains, service connections, and associated appurtenances to supply potable water prior to disconnecting service of an existing watermain on a temporary basis.

493.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be as specified in the Contract Documents.

493.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

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493.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 206 Grading
OPSS 441 Watermain Installation in Open Cut

CSA Standards

B64.5-94 Double Check Valve (DCVA) Backflow Preventers [Part of B64 Series-07, Backflow Preventers and Vacuum Breakers Compendium]

American Water Works Association (AWWA)

C510-07 Double Check Valve Backflow Prevention Assembly

ASTM International

D 1784-11	Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds
D 2241-15	Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
D 3139-98 (2001)	Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
F 477-14	Elastomeric Seals (Gaskets) for Joining Plastic Pipe

NSF International

61-2014a Drinking Water System Components - Health Effects

493.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Associated Appurtenance means structures, devices, and appliances, other than pipe and conduit that are used in connection with a water distribution system, such as valves, hydrants, corporation cocks, services, and thrust restraints.

Excavation, Earth and Rock means the excavation classified as earth and rock according to OPSS 206.

Temporary Hydrant means temporary fire hydrant and all associated temporary appurtenances.

Temporary Potable Water Supply Services means temporary watermains, services, hydrants, and all associated appurtenances.

Temporary Services means temporary potable water supply services installed on or just below the ground surface for the purpose of providing potable water to customers while the existing watermain is out of service.

Temporary Watermain means temporary potable water supply hose or pipe installed on or just below the ground surface for the purpose of providing potable water to temporary services and temporary fire hydrants while the existing watermain is out of service.

Watermain means an installation designed for the conveyance of water under pressure using circular pipe.

493.04 DESIGN AND SUBMISSION REQUIREMENTS

493.04.01 Submission Requirements

The following information shall be submitted to the Contract Administrator 14 Days prior to the commencement of any work requiring temporary potable water supply services:

a) Temporary potable water supply services plans including installation, operation, testing procedures, and a list of material and equipment to be used.

b) Temporary hydrant details.

493.05 MATERIALS

493.05.01 General

The pipe size, type, and class shall be as specified in the Contract Documents.

Fittings shall be suitable for and compatible with the pipe material and class with which they are used.

All materials in contact with potable water shall be NSF/ANSI 61 compliant and, if being reused, shall have been used exclusively for potable water services in the past.

All materials shall be capable of withstanding 860 kPa pressure and all other conditions of use.

493.05.02 Temporary Potable Water Supply Services

The pipe, hose, and all other materials used in conjunction with the temporary potable water supply services shall be as follows:

a) Flexible hose jackets shall be abrasion resistant, either double jacket or specially coated, and be capable of being driven over by vehicles periodically without short term effects.

b) Hose lining shall be of material that does not impart any taste or odour to the water.

c) Hose shall come complete with aluminium couplings with threads.

d) Rigid pipe shall be made of class 12454-B PVC material according to ASTM D 1784. Material shall have a minimum hydrostatic design stress of 14 MPa.

e) PVC shall be formulated with impact modifiers, heat stabilizers, and ultraviolet inhibitors.

f) Pipe extrusion shall meet or exceed all requirements of ASTM D 2241.

g) Joints and couplings shall be according to ASTM D 3139.

h) O-rings shall be according to ASTM F 477.

i) Double check valve backflow preventers shall be according to CSA B64.5 and AWWA C510.

493.05.03 Valves

Valves shall be according to OPSS 441.

493.05.04 Temporary Hydrants

Temporary hydrants shall be as specified in the Contract Documents.

493.07 CONSTRUCTION

493.07.01 General

Written notices to all affected property owners are required a minimum of 48 hours prior to any disruption of water service as a result of the temporary by-pass.

Temporary water services shall be connected to the temporary watermain for each single residential unit or other building.

Connection to the private plumbing system of a residential unit shall be via a wye at an outside tap or an existing water service as specified in the Contract Documents. The connection of single residential units in series is not permitted. Each temporary water service shall have its own valved connection to the temporary watermain.

Connection to other buildings shall be as specified in the Contract Documents.

An adequate water supply shall be available at all times. If the temporary potable water supply service fails, it shall be restored within the time period specified in the Contract Documents.

Care shall be exercised during the installation of temporary potable water supply services to avoid contamination of the services.

No work shall be done during freezing weather, unless directed by the Contract Administrator. No temporary watermains or temporary water services shall be installed or operated during freezing weather. Pipes already in use shall be removed or drained and existing services restored when so directed by the Contract Administrator.

493.07.02 Temporary Watermains

The temporary watermain shall be of a size to provide adequate water supply during peak demand of connected users.

At any connection of a temporary watermain to the water supply and distribution system (e.g., at hydrants) a double check valve backflow preventer shall be installed. Source connections shall be as specified in the Contract Documents.

493.07.03 Temporary Potable Water Supply Services

Temporary potable water supply services for single residential units shall be a minimum of 19 mm inside diameter, or as specified in the Contract Documents. Temporary potable water supply services for other users, including flow to maintain fire protection systems, shall be as specified in the Contract Documents.

The temporary potable water supply service connections shall be valved near the point of connection to the temporary watermain and also valved near the point of connection to a private plumbing system so that both the temporary watermain and the temporary potable water supply services may be disinfected.

493.07.04 Temporary Hydrants

When a hydrant is removed from service, a temporary hydrant and the necessary valves and fittings shall be installed and maintained according to the Contract Documents.

Before permanently shutting down the existing watermain, the temporary hydrants shall be tested to ensure that they are in proper working order.

The hydrants that are out of service during construction operations shall be bagged and clearly marked with a “HYDRANT OUT OF SERVICE” tag.

Once in use, the temporary hydrants shall be maintained until the existing or new hydrants are restored to service.

All temporary potable water supply service attachments to fire hydrants shall be easily removable for fire fighting purposes.

All temporary hydrants shall have reflective tape on the barrel for increased visibility. The temporary hydrants shall stand in an upright position at all times.

493.07.05 Valves

Valves shall be installed at each branch of a temporary watermain.

Before permanently shutting down the existing watermain, the valves shall be tested to ensure that they are in proper working order.

493.07.06 Protection

The Contractor shall provide protection of the temporary potable water supply services at locations such as road crossings, sidewalks, driveways, and walkways.

When temporary watermains cross over the roadway, the asphalt pavement shall be saw cut and removed and the temporary watermain shall be buried. Under no circumstance is a pipe road crossing to remain open and unprotected from vehicular and pedestrian traffic. If a concrete road base exists, it shall not be disturbed.

When temporary potable water supply services are used on full right-of-way reconstruction projects, the temporary potable water supply service piping shall also be buried at all sidewalks, driveways, and walkways.

When temporary potable water supply services are used on projects when the road surface is not being reconstructed, the temporary service piping shall be buried only at all road crossings. When temporary watermains or temporary potable water supply services cross a driveway or a sidewalk, asphalt or another acceptable material shall be mounded over the pipe. A polyethylene sheet shall be placed as a barrier on concrete or interlocking driveways. If the work performed or material used is not to the satisfaction of the Contract Administrator, action shall be taken to rectify the problem. Safety flashers and barricades, as may be required, shall be furnished and maintained. In general, the temporary potable water supply service pipe shall be laid where it causes the least obstruction and is least likely to be damaged.

The Contractor shall protect the temporary potable water supply services installed across all road crossings, sidewalks, driveways, and walkways during the extent of the construction schedule. This shall include earth excavation, backfill, asphalt reinstatement, and ramping material required as directed by the Contract Administrator.

The Contractor shall provide adequate signage at locations where hoses are exposed and may present a public safety hazard, such as blow off hoses at catchbasins.

493.07.07 Leakage Testing

The temporary potable water supply service shall be watertight.

Leakage testing shall be conducted in the presence of the Contract Administrator upon completion of the watermain, including services. Test pressure shall be based on local system requirements as specified in Contract Documents. All leaks shall be repaired prior to covering the pipe.

493.07.08 Flushing and Disinfecting Temporary Watermains and Services

Flushing and disinfecting temporary watermains and services shall be according to OPSS 441.

493.07.09 Removal of Temporary Potable Water Supply Services

Temporary potable water supply services may be used from approximately mid-April to mid-October. All temporary services shall be completely removed by mid-November. Any variation from this schedule shall be approved by the Contract Administrator.

493.07.10 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

All chlorinated water used for testing, flushing, or disinfecting watermains shall be directed to an acceptable outlet in a manner that meets the requirements of all applicable regulations. The method of disposal of chlorinated water is subject to the approval of the Contract Administrator.

493.10 BASIS OF PAYMENT

493.10.01 Temporary Potable Water Supply Services - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

On completion of the supply, installation, flushing, disinfecting, and testing of the temporary potable water supply services prior to putting it in operation, a progress payment to 60% of the above item shall be made. The balance shall be prorated over the remainder of the working period.

Removal or draining of the temporary potable water supply services during freezing weather and its subsequent return to service shall be at no additional cost to the Owner.

Appendix 493-A, November 2019
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer may consider including soil boring data, a geotechnical report, a subsurface report, or a soils report in the Tender Documents.

The designer should include the following in the Contract Documents:

- Pipe size, type, and class. (493.05.01)

- Temporary hydrant requirements. (493.05.04)

- Temporary potable water supply services connection requirements to buildings other than single residential units. (493.07.01)

- Time requirements for restoring the temporary potable water supply service should it fail. (493.07.01)

- Temporary potable water supply services to buildings other than single residential units, including flow to maintain fire protection systems. (493.07.03)

- Service inside diameter. (493.07.03)

- Temporary hydrant and the necessary valves and fittings to be installed and maintained. (493.07.04)

- Test pressure based on local system requirements. (493.07.07)

Where conditions of high ground water exist, external fluids may enter via air release and air/vacuum release valves, therefore, appropriate measures shall be taken.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 1104.030 25 mm Blow Off Installation

CONSTRUCTION SPECIFICATION FOR COMPACTING

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501-A **Commentary**
501-B **Field Compaction Report**

501.01 SCOPE

This specification covers the requirements for compaction of earth and granular materials.

501.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

501.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

501.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 206 Grading
OPSS 401 Trenching, Backfilling, and Compacting

Ontario Provincial Standards Specifications, Materials

OPSS 1010 Aggregates - Base, Subbase, Select Subgrade, and Backfill Material

Ontario Ministry of Transportation Publications

MTO Laboratory Testing Manual:
LS-706 Moisture - Density Relationship of Soils Using 2.5 kg Rammer and 305 mm Drop

ASTM International

D 6938-15 Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

501.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Backfill Material means as defined in OPSS 401.

Bedding Material means as defined in OPSS 401.

Cover Material means as defined in OPSS 401.

Earth means as defined in OPSS 206.

Embedment Material means as defined in OPSS 401.

Rut means a sunken track or groove made at the surface by the passage of vehicles.

Utility Structures means maintenance holes, catch basins, valve chambers, ditch inlets, and other similar structures used to access services such as sewer, water, electric, and telephone to carry out maintenance and repair work.

501.05 MATERIALS

501.05.01 Granular Material

Granular material shall be according to OPSS 1010.

501.05.02 Water

Water shall be free of contaminants that could adversely affect fill material or the environment.

501.06 EQUIPMENT

501.06.01 Compaction

501.06.01.01 General

The type of compaction equipment used shall be suited to the material to be compacted, degree of compaction required, and space available.

Compaction equipment for control strips shall have a minimum static weight of 9,000 kg.

501.06.01.02 Hand Operated Vibratory Equipment

Hand operated vibratory equipment shall have a power output no greater than 9.9 kW.

501.06.02 Water

Equipment for applying water shall be capable of uniform distribution with proper flow control.

501.06.03 Nuclear Moisture and Density Gauge

Each nuclear moisture and density gauge (gauge) shall have been calibrated within the last 12 months either by the manufacturer or other qualified agent against certified density and moisture reference blocks. In addition, the Density Standard Count and the Moisture Standard Count shall be within 2.0% and 4.0%,

respectively, of the most recent calibration values. The registered owner of the gauge shall maintain a valid Radioisotope License for each gauge.

501.07 CONSTRUCTION

501.07.01 General

The method of placing and lift thickness of earth or granular material shall be according to the specifications that govern the Work. When not specified, the lift thickness of earth shall not exceed 300 mm and the lift thickness for granular materials shall not exceed 150 mm.

When field testing indicates that the required degree of compaction cannot be obtained with the equipment in use or the procedure being followed, the operations shall be modified so that the equipment and procedures will produce the required results.

501.07.02 Restricted Zones

Hand operated vibratory type compaction equipment shall be used behind all retaining structures to compact fill material within restricted zones as follows:

a) Abutments and Retaining Walls

An area within a plane extending from the base of the back face of the wall where it contacts the footing upwards at a slope of 1H:1.5V to a maximum distance of 2.5 m from the wall.

b) Wingwalls

An area within 1.5 m from the back face of the wall.

501.07.03 Water for Compaction

Water shall be applied, as necessary, to achieve the degree of compaction required.

When the Contract includes a separate item for water for compaction, the water shall be applied with the approval of the Contract Administrator.

501.07.04 Quality Control

501.07.04.01 General

Quality control (QC) testing shall be carried out to ensure that earth and granular materials used in the Work are compacted according to the requirements as specified in the Contract Documents.

The two methods for conducting QC for compaction are referred to as Method A and Method B. Method A shall be used when Method B is not specified in the Contract Documents.

Field density and field moisture determinations shall be made according to ASTM D 6938.

501.07.04.02 Method A

The MDD shall be determined using LS-706.

Granular materials shall be compacted to a density of 100% of the MDD and all earth materials shall be compacted to a density of 95% of the MDD.

For the situations described in Table 1, Part IV, a minimum of 2 field density and moisture content tests shall be carried out at random locations within each lot.

For all other situations, each lot shall be divided into 4 equal sublots and a minimum of one field density and moisture test shall be carried out at random locations within each sublot.

Test results shall be reported on the Field Compaction Report form in Appendix B or another approved form which shall be signed and submitted to the Contract Administrator.

501.07.04.03 Method B

501.07.04.03.01 General

Compaction testing shall be based on material placed and compacted in the Work on a lot-by-lot basis according to the Lot Testing clause.

Compaction acceptance shall be according to the Acceptance clause and shall be based on target densities established according to the Target Density clause, QC compaction field test results, and, where applicable, a statistical analysis of those results.

501.07.04.03.02 Submission of Test Data

Prior to construction of a control strip, a copy of all QC laboratory test results for LS-706 required by the Control Strip clause to determine optimum moisture content (OMC) of the control strip material shall be delivered to the Contract Administrator.

All field test results and associated information relating to the control strip, including target density, lot location, lift thickness, probe depth, moisture content, wet density, and all QC lot compaction calculations shall be recorded at the time of testing on the Field Compaction Report form in Appendix B. This form shall be available at any time for review, upon request, and shall be submitted to the Contract Administrator prior to placement of any subsequent lift and within two Business Days following the completion of a lot.

501.07.04.03.03 Test Equipment and Operator Training

501.07.04.03.03.01 General

Field density and field moisture measurements for QC compaction testing of earth and granular materials shall be carried out using gauges and ancillary equipment.

Only qualified operators using properly calibrated gauges shall conduct QC compaction testing.

501.07.04.03.03.02 Nuclear Moisture and Density Gauge Requirements

A copy of a valid calibration certificate, including the make, model number, and serial number for each gauge, shall be submitted to the Contract Administrator, prior to use of the gauge in compaction testing.

In addition, the Contract Administrator may request that the operator perform a standardization procedure according to ASTM D 6939.

If the gauge does not meet the standardization requirements or exhibits malfunctions of any kind, the gauge shall be replaced.

501.07.04.03.03.03 Operator Requirements

Each operator shall have been trained in the safe operation, transportation, and handling of the gauge.

Prior to conducting QC compaction testing, the operator shall provide acceptable proof of proficiency in the use of a gauge and the correct procedures to determine lot and sublot sizes, field dry density, percent relative compaction, mean, standard deviation, and the Quality Index of a compacted lot of material by submitting one of the following:

a) a gauge operator certification document or card from a training program acceptable to the Owner and conducted within the Province of Ontario within the last 2 years; or

b) a document (e.g., instruction notice or letter) signed by the Owner showing that the operator has demonstrated proficiency on a Contract either constructed or being constructed for the same Owner within the same construction year as the compaction testing being carried out for this Contract.

If the operator cannot provide either of the two documents stated above, then at the Contract Administrator's discretion, the operator shall demonstrate his or her proficiency to the Owner. In this case, arrangements shall be made with the Contract Administrator regarding the schedule, location, and materials for such demonstrations. The first 2 demonstrations may include up to 5 operators and 5 gauges and shall be carried out at no charge. Additional demonstrations shall be charged at the rate of $500. Where a demonstration is carried out, acceptability of the operator shall be valid for the current calendar year only.

501.07.04.03.04 Target Density

New target densities shall be established for each separate component of the Work (e.g., backfilling of a trench, construction of a granular base, or placement of cover) at the following times:

a) For earth and granular materials:
   i. At the time of initial use of each source.
   ii. When there is a perceptible change in the appearance or gradation of the materials or both.
   iii. At least once per calendar year on all carry-over Contracts.

b) For earth being placed:
   i. As backfill, after QC lots representing 2,000 tonnes or 1,000 m^3 of material have been completed, whether accepted or rejected, on the basis of one set of target density values, or
   ii. For all other purposes, after each 10 QC lots of material have been completed, whether accepted or rejected, on the basis of one set of target density values.

c) For granular materials being placed:
   i. As backfill, or at the discretion of the Contract Administrator, any other areas, after QC lots representing 5,000 tonnes or 2,500 m^3 of material have been completed, whether accepted or rejected, on the basis of one set of target density values, or
   ii. For all other purposes, after each 25 QC lots of material have been completed, whether accepted or rejected, on the basis of one set of target density values.

The new target density shall be established by the construction of a control strip according to the Control Strip clause, except the new target density shall be based on the maximum dry density (MDD) as determined by LS-706 not more than 14 Days prior to placing the material, when:

a) Placing material in confined areas that do not allow equipment meeting the requirements specified in the Compaction clause to be used.

b) With the consent of the Contract Administrator, a control strip cannot be reasonably constructed or is impractical.

The MDD used for the new target density shall be the average of the MDD calculated from a minimum of three independent samples selected from the material to be used.

501.07.04.03.04.01 Control Strip

Prior to construction of a control strip:

a) A minimum notice of 24 hours shall be given to the Contract Administrator, and

b) The optimum moisture content (OMC) of the material shall be determined according to LS-706.

Each control strip shall consist of a single uniform lift not more than 300 mm in depth and covering at least 400 m². The surface of each control strip shall be graded flat.

Prior to compaction, the field moisture content of the control strip material shall be determined at a minimum of three randomly selected locations. The average moisture content at those three locations shall be no less than 2.0% lower than and no more than 1.0% greater than the OMC of the control strip material. If the average moisture content is not within this range, the moisture content of the material shall be uniformly adjusted (e.g. by adding water and re-mixing or scarifying and drying). The material shall then be graded flat and re-tested. This process shall be repeated until the average moisture content of the material, at a minimum of three randomly selected locations, is no less than 2.0% lower than and no more than 1.0% greater than the OMC of the control strip material.

When the OMC is within the acceptable range, the compaction equipment shall make six passes over the entire surface of the control strip. A pass shall be deemed to be compaction of the full width of the control strip in one direction only. The field wet density and field moisture content shall be determined at a minimum of three randomly selected locations. The average dry density from these locations shall be calculated and used as the initial dry density value.

All passes of the compaction equipment for the control strip shall be carried out in vibratory mode at a speed of no more than 5 km/hour.

The compaction equipment shall then make 2 additional passes over the entire surface of the control strip.

A minimum of three separate random field density and moisture content determinations shall then be made and a new average dry density shall be calculated.

If the new average dry density exceeds the previous value by more than 0.030 t/m³, then additional passes of the equipment shall be carried out as described above. If the new average dry density does not exceed the previous value by more than 0.030 t/m³, then the compaction of the control strip shall be considered complete.

Upon completion of the control strip, an additional seven field wet density and moisture content tests shall be taken at random locations and the dry density values determined. The target density of the control

strip shall be the average of the dry density values determined at the seven additional random locations plus the three most recent values determined for completion of the control strip.

501.07.04.03.05 Lot Testing

For compaction control, a unique set of lots distinguished from each other by an appropriate letter or number designation, shall be established for each of the following:

a) Each separate component of the Work (e.g., backfilling a structure or a trench or construction of a granular base).

b) Materials from different sources.

c) Materials with different compaction properties.

d) When recompaction is carried out following restoration, scarification, or placement of additional material onto previously tested and accepted lots.

e) When directed by the Contract Administrator.

The individual lots within each unique set of lots shall be consecutively numbered and with no duplication. Lot sizes shall not exceed the limits as shown in Table 1.

All visibly soft or loose areas shall be compacted prior to testing.

For the situations described in Table 1, Part IV, a minimum of 2 field density and moisture content tests shall be carried out at random locations within each lot.

For all other situations, each lot shall be divided into 4 equal sublots and a minimum of one field density and moisture test shall be carried out at random locations within each sublot and the results used to calculate the Quality Index according to the Quality Index clause.

In addition, regardless of the situation, when a lot of material is split between both sides of a pipe, sewer, or culvert, at least one field density and moisture content test shall be taken on each side of that pipe, sewer, or culvert.

The gauge probe shall extend to the full depth of the lift, unless otherwise allowed by the Modified Layer Compaction Method according to OPSS 206. The probe shall not extend beyond the lift being tested.

During the compaction process, the field wet density value and moisture content for each gauge test shall be recorded on the Field Compaction Report form in Appendix B. The field dry density of each sublot shall then be calculated as a percentage of the target density to the nearest 0.1%. The mean and standard deviation and the Quality Index, where applicable, of the field dry density values shall be calculated to the nearest 0.1% and recorded on the form for each lot.

The Field Compaction Report form in Appendix B shall be constantly updated with new test data and the associated calculations completed as the testing is being done. This form shall be made available to the Contract Administrator at any time, upon request.

501.07.04.03.06 Quality Index

The Quality Index (Q_i), shall be calculated from the mean ($\bar{x}$) and standard deviation (s) of the percent target density which has been determined from all sublots within a QC compaction lot during the compaction process. The values for Quality Index, lot mean, and lot standard deviation shall be computed as follows:

a) For materials placed in embankments within 50 m of a structure; placed as bedding, embedment, cover or backfill material to pipes, sewers, or culverts; or placed as backfill to structures, utility structures, o small foundations (e.g., anchor blocks, sign posts, and formwork):

For earth materials: $Q_i = \frac{\bar{x} - 95}{s}$ For granular materials: $Q_i = \frac{\bar{x} - 98}{s}$

b) For materials placed in all other situations:

For earth materials: $Q_i = \frac{\bar{x} - 90}{s}$ For granular materials: $Q_i = \frac{\bar{x} - 95}{s}$

Where:

Q_i = Quality Index, calculated to two decimal places.

$\bar{x}$ = Lot mean, the statistical value that describes the arithmetic average of sublot test results (dry density expressed as a percentage of the target density). Lot mean is the sum of individual sublot test results divided by the number of test results, calculated to 0.1% as follows:

$$\bar{x} = \frac{x_1 + x_2 + x_3 + x_4}{4} = \frac{1}{4}\sum_{i=1}^{4} x_i$$

S = Lot standard deviation (σ_{n-1}), the statistical value that describes the distribution of sublot test results (dry density expressed as a percentage of the target density) about the lot mean. Standard deviation is the square root of the sum of the squares of the difference between each sublot test result and the lot mean divided by the number of test results minus one. It is calculated to 0.1% using the following expression:

$$s = \sqrt{\frac{\sum_{i=1}^{4} (x_i - \bar{x})^2}{3}}$$

501.07.04.03.07 Acceptance

For the situations described in Table 1, Part IV, acceptance or rejection of a QC lot for compaction shall be based on 2 or more random field density and moisture content tests taken within the lot. For a lot to be acceptable, all tests shall be at least 100% and 98% of the target density established for granular and earth materials, respectively. Otherwise, the QC lot shall be rejected for compaction.

For all other situations, acceptance or rejection of a QC lot for compaction shall be established by calculation of the Quality Index, according to the Quality Index clause. When Q_i has a value equal to or greater than 1.47, the QC lot shall be accepted; otherwise, the lot shall be rejected for compaction.

Accepted QC lots damaged by vehicular traffic shall be restored prior to placement of any overlying material. Surfaces of accepted QC lots with ruts greater than 50 mm in depth in earth or 25 mm in depth in granular materials shall be regraded and the upper lift recompacted to meet the specified compaction requirements. Materials that cannot be successfully recompacted shall be removed and replaced with new material.

501.07.04.03.07.01 Rejected Lots

If a QC lot is rejected for compaction, the lot shall be recompacted with adjustment to the moisture content, as required, until satisfactory compaction is achieved. The recompacted lot shall be retested and a decision made, as described in the Acceptance clause.

When compaction of a QC lot does not meet the acceptance criteria and when the Contract Administrator has been satisfied that this is not a result of the Contractor's operation or equipment, a new target density shall be established for that operation.

501.07.05 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

501.08 QUALITY ASSURANCE

501.08.01 General

Field density and field moisture determinations shall be made in accordance with ASTM D 6938.

When Method B is specified for the QC of compaction, then Method B shall be used for quality assurance (QA).

501.08.02 Method A

The MDD shall be determined using LS-706.

Granular materials shall be compacted to a density of 100% of the MDD and all earth materials shall be compacted to a density of 95% of the MDD.

Test results shall be reported on the Field Compaction Report form in Appendix B or another approved form which shall be signed and submitted to the Contract Administrator.

501.08.03 Method B

501.08.03.01 General

The Contract Administrator shall conduct random testing or inspection of QC records or both to establish the acceptability of the QC compaction testing and verification of the field moisture content, field dry density, OMC, MDD, target density, and the Quality Index, where applicable.

The Contract Administrator may verify that the target density established for a control strip is based on the use of suitable compaction equipment. Provided that the MDD and OMC values determined by LS-706, as applicable, indicate an adequate target density is being achieved, the compaction equipment shall be considered suitable. If the compaction equipment is not capable of obtaining an adequate target density at the required moisture content, the equipment shall be considered unsuitable and shall be replaced with equipment that is able to obtain an appropriate target density.

Reasonable access to a control strip or to compacted QC lots shall be provided prior to placement of subsequent lifts of material. Subsequent lifts, including HMA, may not be placed until QA testing has been conducted or waived by the Contract Administrator.

501.08.03.02 Gauge Verification

Gauge verification QA shall consist of taking 4 random field density and moisture content measurements of a compacted lot or control strip and the subsequent calculation of the average dry density. Provided that the average dry density determined by QC test results for the same material is within 139 kg/m^3 for granulars and 150 kg/m^3 for earth when compared with the QA average dry density, the QC test results shall be considered valid.

501.08.03.03 Compaction

For the situations described in Table 1, Part IV, compaction QA shall consist of taking 2 or more random field density and moisture content measurements of each compacted lot and the subsequent determination of percent target density.

For all other situations, compaction QA shall consist of taking 4 random field density and moisture measurements of a compacted lot or control strip and the subsequent calculation of the Quality Index for the lot.

Provided that the lot is acceptable, according to the requirements specified in the Acceptance clause, no further action shall be taken.

However, if the lot is rejected based on compaction testing or demonstrates errors in QC reporting, an investigation shall take place to determine and resolve the discrepancies. The investigation may include, but is not limited to, any of the following:

a) Recompaction of the lot.

b) Retesting of the lot by the Contractor.

c) Establishment of a new target density by control strip.

d) Re-inspection of the gauge or operator or both by the Owner.

e) Recalibration of the gauges.

f) Removal of unsuitable materials.

501.08.03.04 Quality Control Records Inspections

QC records of the lot or control strip selected by the Contract Administrator shall be inspected for calculation errors, missing test data, or improper lot quantities. If errors or omissions are found that identify insufficiently compacted or improperly or untested lots, the Contractor shall make all such lots available and recompact or retest these lots or both so that they comply with the specified compaction requirements.

501.08.03.05 Charges

The Contract Administrator shall charge the Contractor $450.00 for each lot that requires retesting which has been identified through QA compaction testing or a review of QC records. In addition, immediately following the discovery of a discrepancy or inadequate compaction, all new lots shall be subjected to QA compaction testing prior to acceptance. If any of the new lots do not meet the specified compaction requirements, the Contractor shall be charged a fee of $450.00 for each lot. These conditions shall continue until 3 consecutive new lots have met the specified compaction requirements.

501.09 MEASUREMENT FOR PAYMENT

501.09.01 Actual Measurement

501.09.01.01 Water for Compaction

Measurement of water for compaction shall be in cubic metres using one of the following methods:

a) The mass of the water shall be determined by weighing as specified in the Contract Documents. The mass of the water shall be converted to cubic metres using a factor of 1,000 kg to 1 m^3.

b) The water tank shall be measured and its volume computed in cubic metres.

c) The water shall be measured through a water meter of approved design.

501.10 BASIS OF PAYMENT

501.10.01 Compaction

Payment at the Contract price of the appropriate tender item requiring compaction of earth and granular materials shall be full compensation for all labour, Equipment, and Material to do the work of compacting, including the water used for compaction, unless the Contract contains a separate tender item for Water for Compaction.

Any work required to repair or remove and replace damaged QC lots accepted using Method B shall be at no additional cost to the Owner.

Replacement of unsuitable equipment to obtain an appropriate target density using Method B shall be at no additional cost to the Owner.

Replacement of a gauge shall be at no additional cost to the Owner.

Any work required to recompact or retest material as a result of QA compaction testing or QC records inspection shall be at no additional cost to the Owner.

501.10.02 Water for Compaction - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

When the Contract does not contain a separate tender item for water for compaction, the Contract price for the tender item in which the water for compaction is used shall include full compensation for all labour, Equipment, and Material to do the work.

TABLE 1
Compaction Lot Size

Part	Construction	Lot Size
I	Earth embankments, granular base, granular subbase, and granular shoulders.	Every lift, 500 m maximum length. (Note 1)
II	Structure approach fill for earth.	Every lift, 50 m maximum length
III	Bedding, embedment, cover, or backfill material for pipe and Utility sections > 20.0 m in length that are being placed in one operation, earth or granular.	Every lift, 200 m maximum length.
IV	Bedding, embedment, cover, or backfill material for pipes and Utility sections ≤ 20.0 m in length that are being placed in one operation or backfill to utility structures or small foundations (e.g., anchor blocks, sign posts, and formwork), earth or granular.	Every lift, 20 m maximum length.
V	Structure backfill and culvert bedding, embedment, cover, or backfill material, granular.	Every lift for every stage of construction.

Note:

1. The width of the lot shall be the limits established for the placement of current material only and shall not include adjacent material to be placed at a future date.

Appendix 501-A, November 2017
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should determine if the following is required and, if so, specify it in the Contract Documents:

- Use of Method B. (501.07.04.01)

It should be recognized that the nuclear gauge may not be suitable for compaction Granular B Type II.

Method A is based on laboratory testing to determine optimum moisture content and maximum dry density and is generally used by municipalities.

Method B is a statistically based end result method that recognizes the variability of materials and testing and is generally used by the Ministry of Transportation of Ontario.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

FOR USE IN MUNICIPAL CONTRACTS, WHEN REFERENCED IN THE CONTRACT DOCUMENTS

Note: **This is a non-mandatory Additional Information Appendix intended to provide supplementary requirements for the OPS specification in a municipal contract, when the appendix is invoked by the Owner. It is written in mandatory language to permit invoking it by reference in the Contract Documents. If the appendix has not been invoked by reference in the Contract Documents, it does not apply.**

FIELD COMPACTION REPORT

	Acceptance Based on a Control Strip "C"	Acceptance Based on a Proctor Test "P"
MATERIAL TYPE:		
SOURCE:		

☐QC ☐QA ☐Referee

CONTRACT #:			
ROAD / STRUCTURE:		**MUNICIPALITY:**	
PROJECT DESCRIPTION:			
CONTRACTOR:		**CONTRACT ADMINISTRATOR:**	

GAUGE (make /model):

Serial No.:

STANDARD READINGS FOR NUCLEAR GAUGE				
	Calibration	Reference	Difference (%)	
Density				(±2.0% max)
Moisture				(±4.0% max)

TARGET DENSITY		
Control Strip		t/m^3
Standard Proctor Test (LS-706):		
MDD		t/m^3
OMC		%

QUALITY INDEX, Q_i (i.e. MTO's Requirements)

Earth: $Q_i = \frac{\bar{x}-90}{s}$ Granular: $Q_i = \frac{\bar{x}-95}{s}$

For embankments within 50m of a structure or backfill to pipes, sewers, culverts or structures

Earth: $Q_i = \frac{\bar{x}-95}{s}$ Granular: $Q_i = \frac{\bar{x}-98}{s}$

Test		**Item Requiring Fill or Backfill (Use the Appropriate Checkboxes)**							**Location/GPS Coordinates**		Lift Thickness (cm)	Probe Depth (cm)	Target Density From Control Strip "C" or Proctor Test "P"?	Moisture Content, %	**Density**			**Relative Compaction**					Accepted (**A**) Rejected (**X**) Retest (R) (Note 2)
Lot / Item #	Sublot / Test #	Embankment	Structure	Foundation	Sewer	Culvert	Watermains	Other:	Station / Latitude	Offset / Latitude					Count/minute	Wet Density, tonnes/m^3	Dry Density, tonnes/m^3	% target density	Lot Mean $\bar{x}$	Lot Standard Deviation s	% Proctor Acceptance Limit	$Q_{i\ (Note\ 1)}$	
	1	☐	☐	☐	☐	☐	☐	☐															
	2																						
	3																						
	4																						
	1	☐	☐	☐	☐	☐	☐	☐															
	2																						
	3																						
	4																						
	1	☐	☐	☐	☐	☐	☐	☐															
	2																						
	3																						
	4																						
	1	☐	☐	☐	☐	☐	☐	☐															
	2																						
	3																						
	4																						

NOTES: 1. Q_i must be based on at least 3 tests to be valid. If Qi ≥ 1.47, then 99% of the lot will have compaction above the specified limits (i.e. based on 4 tests) , otherwise, the lot is rejected and shall be recompacted & retested.

2. Retested areas should be indicated with "R" using the original lot number.

REMARKS:

TECHNICIAN:

PRINT NAME

SIGNATURE

DATE

COPIES TO: ☐ **Contract Administrator** ☐ **Contractor** ☐ **Municipality**

ONTARIO
PROVINCIAL
STANDARD
SPECIFICATION

OPSS.MUNI 506
NOVEMBER 2017
(Formerly OPSS 506 November 2013)

Note: The MUNI implemented in November 2017 replaces OPSS 506 COMMON, November 2013 with no technical content changes.

CONSTRUCTION SPECIFICATION FOR DUST SUPPRESSANTS

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506-A **Commentary**

506.01 SCOPE

This specification covers the requirements for dust suppressants and their application.

506.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

506.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

506.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Material

OPSS 2501 Calcium Chloride
OPSS 2503 Magnesium Chloride Solid and Magnesium Chloride Solution

Others

Environmental Protection Act, Ontario Regulation 347, General - Waste Management - R.R.O. 1990

Ministry of the Environment and Climate Change (MOECC) - Certificate or Provisional Certificate of Approval for a Dust Suppression Waste Management System

506.04 DESIGN AND SUBMISSION REQUIREMENTS

506.04.01 Submission Requirements

Dust suppressants other than water, calcium chloride solid, calcium chloride solution, magnesium chloride solid, magnesium chloride solution, and calcium-magnesium chloride blend, or as specified in the Contract Documents shall be approved by the Contract Administrator. The following shall be submitted with a request to approve the dust suppressant within one week of execution of the Contract:

a) The name of the material.

b) The name of the manufacturer or supplier.

c) The manufacturer's guidelines and recommendations for application rates that meet or exceed the performance of calcium chloride or magnesium chloride.

Dust suppressants containing waste material shall be as approved by the Contract Administrator. A copy of a Certificate or Provisional Certificate of Approval for a Dust Suppression Waste Management System shall also be included with the request to approve the dust suppressant. The certificate shall be valid for:

a) The entire period of the Contract.

b) The entire area within the limits of the Contract and the entire haul route.

c) The equipment to be utilized.

d) The point of supply.

e) The relevant Ministry of Environment waste classification.

f) Mixtures with any other material, with the exception of water, if mixtures are to be applied.

Prior to the application of dust suppressants containing waste material, the Contract Administrator shall be provided with a completed blue coloured copy (#5) of the Ontario Regulation 347, General - Waste Management manifest for each shipment of waste.

506.05 MATERIALS

506.05.01 Water

Water shall be free of contaminants that could adversely affect fill material or the environment.

Water shall be free of foreign material that would alter the dust suppressant solution or cause blockage in the spray equipment.

506.05.02 Calcium Chloride Solid, Calcium Chloride Solution, and Calcium-Magnesium Chloride Blend

Calcium chloride solid, calcium chloride solution, and calcium-magnesium chloride blend shall be according to OPSS 2501.

Calcium chloride solution may be substituted for calcium chloride solid.

506.05.03 Magnesium Chloride Solid and Magnesium Chloride Solution

Magnesium chloride solid and magnesium chloride solution shall be according to OPSS 2503.

Magnesium chloride solution may be substituted for magnesium chloride solid.

506.06 EQUIPMENT

506.06.01 General

Application equipment shall be capable of distributing the dust suppressant in a uniform manner at an application rate specified in the Contract Documents.

506.06.02 Pressure Distributors

Pressure distributors shall be propelled by a power unit capable of accurately maintaining any speed required for spraying and shall be provided with the following minimum equipment:

a) A pump capable of developing in the spray manifold a constant uniform pressure to sustain the required application.

b) A pressure gauge indicating the pressure within the spray bar graduated in increments of 15 kPa or less and visible to the operator.

c) A rear mounted spray bar having a cab-activated positive and instant shut off that can be set at variable heights parallel to the surface and to any spraying width from 1 to 3 m to spray any portion of the roadway surface, including the shoulders. The spray bar nozzles shall be:

   i. All of the same manufacture and size.
   ii. Clean and in good working condition.
   iii. Designed and set to ensure uniform fan shaped spray without atomization.

   Nozzles shall be set in the spray bar at an angle permitting each spray fan to overlap adjacent spray fans in such a manner that complete coverage of the spray area is maintained should there be a malfunction of one nozzle.

d) A strainer installed in the feed system to prevent clogging of the spray bar nozzles.

e) A device or method that allows the operator to determine the volume remaining in the tank to an accuracy of 200 litres.

f) Splash guards or other approved devices for shoulder spraying that shall permit spraying immediately adjacent to the pavement without over-spraying the pavement surface.

g) A system (e.g., meter, GPS device, ground speed sensors, or calibration charts) that allows the operator to determine the rate of application with accuracy while spreading the dust suppressant.

506.07 CONSTRUCTION

506.07.01 General

Dust suppressants shall be applied according to the obligations imposed by any Certificate or Provisional Certificate of Approval for a Dust Suppression Waste Management System.

Water shall be the only dust suppressant applied within two weeks before the placement of any asphaltic concrete materials or the application of surface treatments.

Approved dust suppressants other than water, calcium chloride solid, calcium chloride solution, magnesium chloride solid, magnesium chloride solution, and calcium-magnesium chloride blend shall be applied according to the manufacturer's guidelines and application rates.

Steps shall be taken as necessary to control dust resulting from operations or by public traffic such that it does not:

a) affect traffic,

b) enter surface waters, or

c) escape beyond the right-of-way to cause a nuisance to residents, businesses, or utilities.

Dust suppressants shall be applied in a manner that avoids ponding, runoff, drifting, and tracking of the material beyond the area of application.

Dust suppressant application shall not proceed during periods of rain when the surface is in a saturated condition or on areas of ponded water.

Dust suppressants other than water shall not be applied when weather forecasts indicate a high probability of rainfall in order to minimize loss of the material from the intended area of application. Areas receiving rainfall within 6 hours after application may require reapplication of the material.

Dust suppressants containing waste material shall not be stored on the Owner's property.

506.07.02 Dust Suppressant Solution

Dust suppressant solutions shall be applied by a pressure distributor. The application rate per kilometre shall be confirmed by running 250 m test sections in the presence of the Contract Administrator. Solution application rates shall be measured in t/km or in L/m^2.

For the maintenance of existing roadways, dust suppressant solutions shall be applied to a prepared surface. Work shall commence within 3 Working Days of receiving notice from the Contract Administrator and shall proceed continuously until completed.

506.07.03 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

506.09 MEASUREMENT FOR PAYMENT

506.09.01 Water for Dust Suppression

Measurement of water for dust suppression shall be by volume in cubic metres by one of the following methods for the quantity used in the work:

a) The mass of the water shall be determined by weighing according to the Contract Documents and shall be the difference between the mass of the empty water tank and carrying vehicle and the mass of the full tank and carrying vehicle. The mass of the water shall be converted to cubic metres using a factor of 1,000 kg to 1 m^3.

b) The water tank shall be measured and its volume computed in cubic metres.

c) The water shall be measured through a water meter acceptable to the Contract Administrator.

506.09.02 Calcium Chloride Solid and Magnesium Chloride Solid

Measurement for calcium chloride solid and magnesium chloride solid shall be by mass in kilograms.

506.09.03 Calcium Chloride Solution

Measurement of calcium chloride solution shall be by mass in tonnes of solution, by volume in litres of solution, or by mass of equivalent solid as specified in the Contract Documents. The mass and volumetric measurement of calcium chloride solution shall be according to OPSS 2501.

506.09.04 Magnesium Chloride Solution

Measurement of magnesium chloride solution shall be by mass in tonnes of solution, by volume in litres of solution, or by mass of equivalent solid as specified in the Contract Documents. The mass and volumetric measurement of magnesium chloride solution shall be according to OPSS 2503.

506.09.05 Calcium-Magnesium Chloride Blend

Measurement of calcium-magnesium chloride blend shall be by mass in tonnes of solution or by volume in litres of solution as specified in the Contract Documents. The mass and volumetric measurement of calcium-magnesium chloride blend shall be according to OPSS 2501.

506.10 BASIS OF PAYMENT

506.10.01 Water for Dust Suppression - Item
Calcium Chloride Solid - Item
Calcium Chloride Solution - Item
Magnesium Chloride Solid - Item
Magnesium Chloride Solution - Item
Calcium-Magnesium Chloride Blend - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

When the Contract does not contain a separate tender item for any of the above items, the Contract price for the applicable tender item for which dust suppression is required shall be full compensation for all labour, Equipment, and Material to do the work.

Appendix 506-A, November 2017
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should determine if the following is required and, if so, specify it in the Contract Documents:

- The dust suppressant material by type. (506.04.01)

- Method of measurement for dust suppressant solution. (506.09.03, 506.09.04, 506.09.05)

- A tender item for payment of a dust suppressant. (506.10.01)

When a dust suppressant other than water, calcium chloride solid, calcium chloride solution, magnesium chloride solid, magnesium chloride solution, or calcium-magnesium chloride blend is to be applied, the concentration and the volumetric conversion should be identified.

The proper use and application of all dust suppressants is the responsibility of the applicator and is subject to applicable Ministry of Environment requirements under legislation such as the *Environmental Protection Act* (EPA) and the *Ontario Water Resources Act*.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

CONSTRUCTION SPECIFICATION FOR REMOVAL

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510.09 **MEASUREMENT FOR PAYMENT**

510.10 **BASIS OF PAYMENT**

APPENDICES

510-A **Commentary**

510.01 SCOPE

This specification covers the requirements for demolition, salvage, removal, and in-place abandonment, either completely or partially, of those materials and structures so designated, including the requirements for backfilling resulting excavations, trenches, holes, and pits.

510.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

510.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

510.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 301	Restoring Unpaved Roadway Surfaces
OPSS 310	Hot Mix Asphalt
OPSS 410	Pipe Sewer Installation in Open Cut
OPSS 421	Pipe Culvert Installation in Open Cut
OPSS 422	Precast Reinforced Concrete Box Culverts and Box Sewers in Open Cut
OPSS 501	Compacting

Ontario Provincial Standard Specifications, Materials

OPSS 1004	Aggregates - Miscellaneous
OPSS 1150	Hot Mix Asphalt
OPSS 1151	Superpave and Stone Mastic Asphalt Mixtures
OPSS 1301	Cementing Materials
OPSS 1302	Water
OPSS 1350	Concrete - Materials and Production

Ontario Ministry of Transportation Publications

Structural Manual

CSA Standards

S6-14 Canadian Highway Bridge Design Code

510.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Bridge Structure means that portion of a bridge and associated wing and retaining walls above the bridge footing, excluding modular bridges.

CIR means cold in-place recycling.

CIREAM means cold in-place recycling with expanded asphalt.

Concrete Appurtenances means as defined in OPSS 410, 421, and 422.

Culvert means a single or multiple cell structure designed to provide an opening under a roadway, pedestrian way, railway, or side entrance for the passage of surface water, livestock, or pedestrians.

Curb and Gutter means any combination of curb, gutter, curb with gutter, gutter setbacks, bullnoses, gutter outlets, and spillways.

Engineer means a professional engineer licensed by the Professional Engineers Ontario to practice in the Province of Ontario.

HIR means hot in-place recycling.

Pipe means any closed conduit originally designed to convey liquid or gas.

Sundry Asphalt Pavements means paved islands, medians, boulevards, and walkways.

510.04 DESIGN AND SUBMISSION REQUIREMENTS

510.04.01 Design Requirements

Caps for capping maintenance holes, catch basins, ditch inlets, and valve chambers shall be designed according to CAN/CSA S6 and the Structural Manual.

510.04.02 Submission Requirements

510.04.02.01 Removal of Bridge Structures

Two weeks prior to commencement of the work, a work plan shall be submitted to the Contract Administrator outlining the equipment to be used, dust and debris control, and the sequence of removals for bridge demolition.

Where any portion of the bridge structure is to support traffic or equipment loading during demolition, the entire structure shall be evaluated for load carrying capacity according to the CAN/CSA S6 and the Structural Manual.

All submissions shall bear the seal and signature of the design Engineer and design check Engineer.

510.05 MATERIALS

510.05.01 Mortar

Mortar shall consist of a mixture of one part Portland cement according to OPSS 1301 and three parts mortar sand according to OPSS 1004, wetted with sufficient water to make the mixture plastic. Water shall be according to OPSS 1302.

510.05.02 Concrete

Concrete for concrete seals shall be according to OPSS 1350 with minimum specified 28-Day compressive strength of 30 MPa.

Concrete for filling abandoned pipes shall be according to OPSS 1350 with minimum specified 28-Day compressive strength of 15 MPa.

510.05.03 Grout

Grout shall consist of a mixture of one part Portland cement according to OPSS 1301 and two parts mortar sand according to OPSS 1004, wetted with sufficient water to make the mixture plastic. Water shall be according to OPSS 1302.

510.07 CONSTRUCTION

510.07.01 General

Removal, abandonment, demolition, or salvage of a particular item shall be as specified in the Contract Documents.

The work shall include all associated excavation, backfill, compaction, trimming, plugging, capping, filling, sealing, and right-of-way preparation.

If provided, existing drawings from the Owner pertaining to bridge structures, modular bridges, culverts, and noise barriers designated for removal shall be reviewed prior to commencement of any activities.

Stockpiling requirements shall be as specified in the Contract Documents.

Where work is done in waterbodies and on waterbody banks, the work shall be according to the Contract Documents.

510.07.01.01 Excavation

Excavation required for the removal work to be carried out shall be part of the removal operation and shall be performed in such a manner as to leave undisturbed any portions not designated for removal.

510.07.01.02 Removal

Removal shall be performed in such a manner and with such equipment as to leave undisturbed and undamaged any portion not designated for removal or salvage. All damaged or disturbed portions shall be corrected expeditiously and repaired to the satisfaction of the Contract Administrator. The broken edges of portions to be left in place that are visible after construction shall be squared and neatly trimmed.

510.07.01.03 Salvage

Any material designated for salvage shall remain the property of the Owner and shall be maintained in a reasonable condition and stockpiled in a manner acceptable to the Contract Administrator.

Salvaged materials that are surplus to the Contract requirements shall be delivered to the location specified in the Contract Documents. When designated for salvage and surplus to the Contract requirements, salvaged frames and related grates or covers shall be kept together as a unit for delivery and stockpiling.

Any material designated for salvage damaged by the Contractor's operations or lost by the Contractor at any time prior to re-use or stockpiling shall be replaced with new material.

510.07.01.04 Backfilling, Compacting, and Trimming

Where a removal or partial removal requires the filling of a resulting trench, hole, or pit, backfilling shall be to the required grade using either suitable excavated material or imported material as required or as specified in the Contract Documents, and shall include levelling and trimming of the site to match required contours and provide adequate drainage. Backfill material shall be placed and compacted according to OPSS 501.

510.07.02 Bridge Work

510.07.02.01 Removal of Bridge Structures and Bridge Footings

The work of bridge structure removal shall include the complete removal of bridge structure components above the top of the bridge footings to the lines and grades specified in the Contract Documents.

The work of bridge footings removal shall include cutting the piles to the underside of the footing and the complete removal of the bridge footings.

510.07.02.02 Removal of Modular Bridges

The work of modular bridge removal shall include the dismantling and removal and salvage of the modular bridge components, all timber in the deck, curbs, running strips, and steel beam guide rail system attached to the bridge. The work shall include the unloading and erection of the launching nose and subsequent dismantling.

Modular bridge components that are the property of the Owner, including the dismantled launching nose, shall be loaded onto transport vehicles, supported on 100 x 100 mm timber to allow forklift access, securely fastened, and then transported to the location specified in the Contract Documents.

All components shall be delivered in good condition during normal working hours and neatly stockpiled. All small parts shall be crated to prevent loss.

The approximate weight of the modular bridge, as specified in the Contract Documents, includes the weight of the steel components of the bridge, the ramps, and the launching nose, but excludes the weight of the wooden deck, construction tools, and rollers.

Vehicles required to transport the launching nose and the modular bridge components and parts shall be provided by the Contractor and of sufficient size to fully support the modular bridge components.

510.07.02.02.01 Operational Constraints

Prior to dismantling of the modular bridge, qualification information shall be provided to the Contract Administrator to ensure that the person supervising the removal of the modular bridge is competent to successfully fulfill such duties.

The Contract Administrator shall be notified a minimum of 7 Days in advance of the date on which modular bridge removal is to commence. The Owner shall make the launching nose available to the Contractor, following such notification.

510.07.02.02.02 Removal of Modular Bridge Substructures

The work shall include the removal of modular bridge substructures, bank seats, cribs, and timber or steel bents, and any rock in the cribs.

Modular bridge substructure materials shall be removed from the right-of-way or managed as specified in the Contract Documents.

Rocks from cribs shall not be placed in any waterbody.

510.07.03 Drainage Work

510.07.03.01 General

Any sediment or deposited material required to be removed shall not be allowed to enter any waterbody.

Frames with grates or covers and watermain appurtenances, within valve chambers that are to be removed, shall be salvaged.

510.07.03.02 Removal of Curb and Gutter

The work shall include the removal of asphalt, concrete, and cut stone curb and gutter. Cut stone curb shall be salvaged.

510.07.03.03 Removal of Asphalt Curb and Gutter

The work shall include the removal of asphalt curb and gutter.

510.07.03.04 Removal of Concrete Curb and Gutter

The work shall include the removal of concrete curb and gutter.

510.07.03.05 Removal of Maintenance Holes, Catch Basins, Ditch Inlets, and Valve Chambers

The work shall consist of the removal of maintenance holes, catch basins, ditch inlets, and valve chambers.

510.07.03.06 Abandonment of Maintenance Holes, Catch Basins, Ditch Inlets, and Valve Chambers

The work shall include the partial removal of maintenance holes, catch basins, ditch inlets, and valve chambers where structures and the Utility systems therein are abandoned. Such partial removal, when within the roadway, shall be to a minimum of 1.0 m below subgrade.

Prior to backfilling, the bottom of each structure designated for partial removal shall be broken to allow for the free movement of groundwater.

As an alternative to partial removal, maintenance holes, catch basins, ditch inlets, or valve chambers may be removed in their entirety.

510.07.03.07 Capping Maintenance Holes, Catch Basins, Ditch Inlets, and Valve Chambers

The work shall include the capping of maintenance holes, catch basins, ditch inlets, and valve chambers where the Utility systems therein are to remain in service. Such capping shall include the removal of all adjustment units. Where the structure exists within the roadbed, the upper portion of the structure shall be removed to a minimum of 1.0 m below subgrade and the walls of the structure shall be saw cut or similarly finished to produce a neat horizontal cut suitable for placing a concrete cap.

510.07.03.08 Removal of Pipes and Culverts

The work shall include the removal of pipes and culverts of 200 mm diameter and greater, including multiple cell timber culverts.

Concrete, clay, and plastic pipes may be removed by rupturing or collapsing the pipe with suitable equipment and leaving the debris in place in a manner as to eliminate all voids and so as not to be detrimental to the work.

When removing pipes that enter into a concrete culvert, maintenance hole, catch basin, ditch inlet, or valve chamber and the structure is to remain in service, the openings left in the structures from the pipe shall be sealed with concrete or brick suitable for outdoor use and mortar. Brick seals shall be a minimum thickness of one brick length. The contact surface of each brick shall be coated with mortar to provide a watertight seal. Concrete seals shall be the minimum thickness of the structure wall.

510.07.03.09 Abandonment of Pipes and Culverts

The work shall include the filling of all pipes and culverts when the Contract Documents specify abandonment.

Abandoned sections of pipes and culverts up to 1,200 mm in diameter shall be filled with grout or concrete.

Access points shall be provided to allow for confirmation that the pipe has been completely filled.

When abandoning pipes that enter into a concrete culvert, maintenance hole, catch basin, ditch inlet, or valve chamber and the structure is to remain in service, the openings in the structure shall be sealed according to the Removal of Pipes and Culverts clause.

510.07.03.10 Removal of Pipe Subdrains

The work shall include the removal of pipe subdrains smaller than 200 mm in diameter.

Excavate, as required, to remove existing pipe subdrains, backfill the resulting trenches with native material, and compact.

510.07.03.11 Removal of Hydrants, Valves, and Watermain Appurtenances

The work shall include the removal or abandonment of hydrants, valves, and watermain appurtenances.

When a hydrant is removed, the hydrant shall be removed with its boot intact and salvaged.

When the mainline is to remain in service after a removal, the work shall include capping at the tee at the mainline.

When a mainline valve is to be abandoned and the valve is not in a valve chamber, the valve box shall be removed.

When a water service connection is abandoned, the work shall include shutting off the service at the mainline.

510.07.04 Fence and Noise Barrier Work

510.07.04.01 Removal of Fence

The work shall include the removal of all fences, regardless of type.

The work shall consist of the dismantling and removal of the fence, including all posts, fence fabric, footings, gates, components, and fittings forming part of the fence designated for removal.

When the means of egress and ingress between the right-of-way and adjacent property is being controlled by an existing fence designated for removal, that control shall be maintained for the duration of the Contract.

When only part of an existing fence is removed, repairs to match the existing fence shall be made to the ends remaining.

510.07.04.02 Removal of Noise Barriers

The work shall include the dismantling of the noise barrier including posts, panels, framing, doors, fire access openings, and the removal of concrete footings to a depth of 1.3 m.

510.07.05 Delineators, Traffic Barriers, and Energy Attenuator Work

510.07.05.01 Removal of Delineator Posts

The work shall include the removal of delineator and guide posts, including wooden, metal, and flexible posts, and associated hardware.

510.07.05.02 Removal of Guide Rail Systems

The work shall include the removal of cable guide rail, steel beam guide rail, and box beam guide rail systems, including cables, steel beams, box beams, channels, hardware, posts, anchor blocks, and anchoring systems to the limits specified in the Contract Documents.

510.07.05.03 Removal of Concrete Barriers

The work shall include the removal of cast-in-place concrete barriers; the removal and salvage of precast concrete barriers; the removal of back to back installed concrete barriers, concrete or granular fill between the back to back concrete barriers, barrier transition sections; and the removal of associated pads and hardware as specified in the Contract Documents.

510.07.05.04 Removal of Energy Attenuators

The work shall include the removal of energy attenuators, including pads and anchoring devices. At specified locations, the energy attenuators shall be dismantled and salvaged as a complete system, including all hardware.

510.07.05.05 Removal of Ramp Closure Gates

The work shall include removal of ramp closure gate concrete footings, gates, signs, and all associated hardware.

The gates and associated hardware shall be salvaged and delivered to the location specified in the Contract Documents.

510.07.06 Pavement Work

510.07.06.01 General

During pavement removal operations, care shall be taken to prevent contamination with granular and other foreign materials.

Removal shall be performed in such a manner as to leave adjacent pavement and structures remaining in place undisturbed.

When the roadway is to be opened to traffic after the daily shut down and full width pavement removal is required, the following shall apply:

a) For two-lane highways, removal shall be done to the same station for the full pavement width prior to shutdown at the end of the day.

b) For multi-lane highways, removal shall be done to essentially the same station for the full pavement width for a specific direction prior to shutdown at the end of the day.

c) Prior to opening the lanes to traffic, temporary ramping shall be provided as specified in the Contract Documents.

Asphalt pavement material from removal operations that is to be used on this Contract or stockpiled for future use by the Owner shall be weighed according to the Contract Documents then processed prior to stockpiling so 100% of the resultant material passes the 26.5 mm sieve. RAP shall be stockpiled according to the requirements of OPSS 1150 or OPSS 1151, as applicable to the Contract.

Removed asphalt pavement materials that are different due to the removal equipment used or pavement type shall be stockpiled separately.

510.07.06.02 Cutting Existing Pavement

Pavement shall be cut for neat removal to the depth specified in the Contract Documents.

Suitable mechanical sawing equipment or pavement milling equipment capable of producing a straight clean vertical face shall be used for cutting the pavement. The existing pavement type, thickness, and, if any, size of reinforcement shall be as specified in the Contract Documents.

510.07.06.03 Removal of Pavement, Treated Base, and Concrete Base

The work shall include the full-depth removal of asphalt pavement, concrete pavement, asphalt pavement from concrete surfaces and concrete base, cement-treated base, and asphalt-treated base. All materials shall be managed as specified in the Contract Documents.

When removed material is to remain temporarily on site due to construction operations, the removed material shall be placed on an asphalt or concrete surface until final disposition.

When the operation for full-depth asphalt removal from concrete base or concrete surfaces other than structures causes thickness reductions or surface variations exceeding 10 mm, the removal operations shall be corrected expeditiously and the damaged concrete areas repaired.

As part of the work of full-depth pavement removal, where traffic is to be maintained throughout the work without the use of a temporary bypass, temporary granular ramping shall be constructed and maintained to convey traffic through the area. The ramping shall be at 20H:1V. Temporary ramps shall be removed to accommodate subsequent construction after traffic has been routed off the temporary ramp.

Following pavement removal, the existing roadway granular shall be restored according to OPSS 301, when such roadway is not designated for abandonment.

Prime, surface treatments, and mulch pavements greater than 50 mm in depth are considered to be asphalt pavement.

This work shall not include removal of materials for jointing done as part of a paving operation.

510.07.06.04 Removal of Asphalt Pavement, Partial-Depth

The work shall include the partial-depth removal of asphalt pavement. Such material shall be managed as specified in the Contract Documents.

The asphalt pavement shall be removed to the average depth specified in the Contract Documents.

Prior to commencing removal operations, all debris, deleterious material, and existing windrows shall be removed from the roadway surface, including material beyond the theoretical roadway width, to provide positive drainage.

If the remaining asphalt pavement does not require further processing or if the remaining asphalt pavement is to be recycled using CIR or CIREAM or HIR processes, then the equipment used for partial depth removal shall be automatically controlled for grade and slope during removal. The surface remaining after removal shall have a constant and continuous crossfall matching the intended surface course crossfall. The surface remaining after removal shall have an even texture and be free of significantly different grooves and ridges in all directions.

Removed asphalt pavement material shall not remain on the roadway after completion of the day's operation. Placing of the material on grade other than a bituminous surface prior to hauling to a stockpile shall not be permitted.

After partial depth removal, the gap between the top of milled surface and the bottom of a 3 m straightedge placed anywhere in any direction on the milled surface shall not exceed 6 mm.

Prior to opening the lane to traffic after partial-depth pavement removal, adjacent granular shoulder material shall be reshaped and compacted to ensure proper drainage of the milled surface and adjoining shoulders.

Partial-depth asphalt pavement removal operations and the resulting surfaces from partial-depth asphalt removal operations shall not be permitted between November 16th and June 1st, unless approved by the Contract Administrator.

510.07.06.04.01 Temporary Ramping

As part of the work of partial-depth pavement removal, at the limits of each completed portion and where traffic is to be maintained, prior to opening to traffic, temporary ramping shall be constructed by milling or hot mix asphalt according to OPSS 310. Temporary ramping shall be removed as part of continuing the removal of asphalt pavement, partial-depth operation from the ramping location or prior to placing permanent pavement materials at the ramping location.

510.07.06.04.01.01 Temporary Transverse Ramping

Temporary transverse ramping shall be constructed at a slope not steeper than 30H:1V.

510.07.06.04.01.02 Temporary Longitudinal Ramping

Temporary longitudinal ramping shall be constructed where partial-depth pavement removal cannot be completed to the same station for the full pavement width prior to daily shut down. Temporary longitudinal ramping, shall be constructed at a slope not steeper than 10H:1V.

Temporary longitudinal ramping shall not be permitted when either of the following conditions exist:

a) the ramping height would be greater than 50 mm, or

b) the pavement slope would cause water to accumulate at the edge of the ramping and extend onto an adjacent lane or shoulder that will be open to traffic.

510.07.06.05 Removal of Asphalt Pavement from Concrete Surfaces on Structures

The work shall include the removal of asphalt pavement and waterproofing from the concrete surfaces on structures. All materials shall be managed as specified in the Contract Documents.

When pavement-milling equipment is used, the weight of milling equipment shall be limited to:

a) 43 tonnes maximum weight for post-tensioned decks and rigid frame decks,

b) 26 tonnes maximum weight for thin slab concrete bridge deck on girders. For thin slab concrete bridge deck on girders, the equipment shall not travel laterally beyond 1.0 m from the centreline of the exterior girder.

When the method of asphalt removal results in impact damage or excessive vibration is observed, operations shall be modified to eliminate these effects.

Unless the Contract Documents specify a concrete or latex-modified concrete overlay is to be placed on the existing concrete deck, the milling operation shall be controlled such that the milling teeth do not come in contact with the concrete deck surface and bridge joints. Any remaining asphalt pavement and waterproofing not removed by rotary milling equipment shall be removed by other methods.

If the milling operation damages the surface of the concrete deck, causing surface variations or concrete thickness reductions exceeding 2 mm, the milling operation shall be corrected expeditiously and the damaged concrete areas repaired. The proposed repair method shall be submitted in writing to the Contract Administrator, prior to commencing repairs. Surface preparation, placement, and curing of the repair materials shall be according to the repair material manufacturer's instructions.

510.07.06.06 Removal of Concrete Pavement, Partial-Depth

The concrete pavement shall be removed to the depths indicated in the Contract Documents.

The equipment used for partial-depth concrete pavement removal shall be automatically controlled for grade and slope during removal. The surface remaining after removal shall have a constant and continuous cross fall matching the intended surface cross fall. The surface remaining after removal shall have an even texture free of significantly different grooves and ridges in all directions.

The removed concrete pavement material shall not remain on the roadway after completion of the day’s operation.

After partial-depth removal of existing concrete pavement, the Contractor shall reshape and compact the existing shoulder material to ensure proper drainage of the remaining surface and adjoining shoulders.

Removal operations and resulting surfaces from removal operations shall not be permitted during the winter months on highways with posted speeds of 80 km/h or higher.

510.07.07 Concrete Work

510.07.07.01 Removal of Concrete

The work shall include the removal of retaining walls; footings; foundations; concrete culverts, including associated wingwalls and retaining walls; concrete appurtenances; and similar concrete structures specified in the Contract Documents.

510.07.08 Right-of-Way Work

510.07.08.01 Preparing Right-of-Way

When preparing the right-of-way is specified in the Contract Documents, all objects and materials within the specified road allowance that interfere with the execution of the work and are not covered under separate removal items, shall be removed under this work. The work includes, but is not limited to the removal of trees less than 150 mm diameter, tree roots and stumps, brush and hedges, culverts, wooden and steel posts, signs, sidewalks, precast or poured driveway curbs, asphalt curbs, boulders, stone walls and retaining walls, and other surface materials that require removal in order to complete all parts of the Contract.

Any precast concrete slabs, bricks and stones, cut stone curbs, timbers, or similar landscaping elements that are removed shall remain the property of the adjacent property owner and shall be piled neatly on such adjacent property.

510.07.08.02 Removal of Driveways, Sidewalks, and Sundry Asphalt Pavements

When collective work to remove driveways and sidewalks needs to be done, work shall include the removal of asphalt, concrete, stone or brick driveways and sidewalks, and sundry asphalt pavements.

510.07.08.03 Removal of Concrete Sidewalk

The work shall include the removal of concrete sidewalk.

510.07.08.04 Removal of Gabions

The work shall include the removal of gabions, including rock and wire.

510.07.09 Overhead Signs and Sign Support Structure Work

Overhead signs and sign support structures shall be salvaged.

Sign support structure footings shall be removed to a minimum of 1.3 m below subgrade.

510.07.10 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

510.09 MEASUREMENT FOR PAYMENT

510.09.01 Actual Measurement

510.09.01.01 Removal of Bridge Footings

Measurement of removal of bridge footings shall be the volume in cubic metres of the concrete removed.

510.09.01.02 Removal of Curb and Gutter
Removal of Asphalt Curb and Gutter
Removal of Concrete Curb and Gutter

Measurement of removal of curb and gutter shall be the length in metres horizontally along the flow lines of the curb and gutter removed, whether straight or circular, without separation into types. When the slope of the curb and gutter is 4H:1V or steeper, then the above measurement is of the slope length.

No deduction shall be made from the measured length for the spaces occupied by maintenance hole and catch basin castings. Where the removal includes runs of curb and gutter that converge to form bullnoses, each run shall be measured for payment and such measurement shall include the concrete fillet within the bullnose.

510.09.01.03 Removal of Maintenance Holes, Catch Basins, Ditch Inlets, and Valve Chambers

For measurement purposes, a count shall be made of the number of maintenance holes, catch basins, ditch inlets, and valve chambers removed regardless of type, depth, or size.

510.09.01.04 Abandonment of Maintenance Holes, Catch Basins, Ditch Inlets, and Valve Chambers, Partial-Depth

For measurement purposes, a count shall be made of the number of maintenance holes, catch basins, ditch inlets, and valve chambers abandoned regardless of type or size.

510.09.01.05 Capping of Maintenance Holes, Catch Basins, Ditch Inlets, and Valve Chambers

For measurement purposes, a count shall be made of the number of maintenance holes, catch basins, ditch inlets, and valve chambers capped regardless of type or size.

510.09.01.06 Removal of Pipes and Culverts

Measurement of removal of pipes and culverts shall be the length in metres horizontally along the pipe or culvert, from one end or end section to the other end or the other end section. Where the grade of the pipe or culvert is 10% or greater, then the above measurement is of the slope length. Pipes and culverts smaller than 200 mm diameter shall be treated as part of the excavation work.

No deduction shall be made from the measured length for the spaces occupied by intermediate maintenance holes, catch basins, ditch inlets, and valve chambers.

510.09.01.07 Abandonment of Pipes and Culverts

Measurement of abandonment of pipes and culverts shall be by length in metres horizontally along the pipe or culvert, from one end or end section to the other end or the other end section. Where the grade of the pipe or culvert is 10% or greater, then the above measurement is of the slope length.

510.09.01.08 Removal of Pipe Subdrains

Measurement of removal of pipe subdrains shall be by length in metres horizontally along the centerline of the pipe subdrains, including outlets.

510.09.01.09 Removal of Hydrants
Removal of Valves
Removal of Watermain Appurtenances

For measurement purposes, a count shall be made of the number of hydrants, valves, and watermain appurtenances removed.

510.09.01.10 Removal of Fence
Removal of Noise Barrier

Measurement of removal of fence and noise barrier shall be the length in metres, horizontally along each fence or noise barrier removed.

510.09.01.11 Removal of Delineator Posts

For measurement purposes, a count shall be made of the number of delineator and guide posts removed.

510.09.01.12 Removal of Cable Guide Rail
Removal of Concrete Barrier
Removal of Steel Beam Guide Rail
Removal of Steel Box Beam Barrier

Measurement of removal of traffic barrier shall be the length in metres horizontally along each type of traffic barrier removed, excluding energy attenuators.

Where cable guide rail and steel box beam barrier are anchored to concrete anchor blocks, measurement shall be made between the end anchor points with no additional measurement made of the overlapping sections at intermediate anchorages.

510.09.01.13 Removal of Anchor Blocks

For measurement purposes, a count shall be made of the number of anchor blocks removed.

510.09.01.14 Removal of Energy Attenuators

For measurement purposes, a count shall be made of the number of complete energy attenuators systems removed.

510.09.01.15 Removal of Ramp Closure Gates

For measurement purposes, a count shall be made of the number of ramp closure gates removed.

510.09.01.16 Cutting Existing Pavement

Measurement of cutting of existing pavement shall be by length in metres along each cut.

510.09.01.17 Removal of Asphalt Pavement
Removal of Asphalt Pavement from Concrete Surfaces
Removal of Concrete Pavement
Removal of Asphalt-Treated Base
Removal of Cement-Treated Base
Removal of Concrete Base

Measurement of removal of asphalt pavement, asphalt pavement from concrete surfaces, concrete pavement, asphalt-treated base, cement-treated base, and concrete base shall be by area in square metres.
No deductions shall be made from the area for the space occupied by maintenance holes, catch basins, and valve chambers.

The full-depth removal of asphalt pavement, asphalt pavement from concrete surfaces, concrete pavement, asphalt-treated base, cement-treated base, and concrete base shall be measured for payment whether on the roadway surface or within an excavation, where such pavement or base has remained in place since its construction.

510.09.01.18 Removal of Asphalt Pavement, Partial-Depth
Removal of Concrete Pavement, Partial-Depth

Measurement of removal of partial-depth asphalt or concrete pavement shall be by area in square metres or by mass in tonnes as specified in the Contract Documents.

510.09.01.19 Removal of Asphalt Pavement from Concrete Surfaces on Structures

Measurement of removal of asphalt pavement from concrete surfaces on structures shall be by area in square metres.

510.09.01.20 Removal of Concrete

Measurement of removal of concrete shall be by volume in cubic metres.

When broken concrete or masonry is used as rip-rap or rock protection, deductions shall not be made from the concrete removal item.

510.09.01.21 Removal of Driveways, Sidewalks, and Sundry Asphalt Pavements

Measurement of removal of driveways, sidewalks, and sundry asphalt pavements shall be by horizontal area in square metres.

510.09.01.22 Removal of Concrete Sidewalk

Measurement of removal of concrete sidewalks shall be by horizontal area in square metres.

510.09.01.23 Removal of Gabions

Measurement of removal of gabions shall be by volume in cubic metres.

510.09.01.24 Removal of Sign Support Structure
Removal of Sign Support Structure Footings

For measurement purposes, a count shall be made of the number of sign supports and sign support footings removed.

510.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

510.10 BASIS OF PAYMENT

510.10.01

Removal of Bridge Structure - Item
Removal of Bridge Footings - Item
Removal of Modular Bridge - Item
Removal of Modular Bridge Substructure - Item
Removal of Curb and Gutter - Item
Removal of Asphalt Curb and Gutter - Item
Removal of Concrete Curb and Gutter - Item
Removal of Maintenance Holes, Catch Basins, Ditch Inlets, and Valve Chambers - Item
Abandonment of Maintenance Holes, Catch Basins, Ditch Inlets, and Valve Chambers Partial-Depth - Item
Capping of Maintenance Holes, Catch Basins, Ditch Inlets, and Valve Chambers - Item
Removal of Pipe and Culverts - Item
Abandonment of Pipes and Culverts - Item
Removal of Pipe Subdrains - Item
Removal of Hydrants - Item
Removal of Valves - Item
Removal of Watermain Appurtenances - Item
Removal of Fence - Item
Removal of Noise Barriers - Item
Removal of Delineator Posts - Item
Removal of Cable Guide Rail - Item
Removal of Concrete Barrier - Item
Removal of Steel Beam Guide Rail - Item
Removal of Steel Box Beam Barrier - Item
Removal of Anchor Blocks - Item
Removal of Energy Attenuators - Item
Removal of Ramp Closure Gates - Item
Cutting Existing Pavement - Item
Removal of Asphalt Pavement - Item
Removal of Asphalt Pavement from Concrete Surfaces - Item
Removal of Concrete Pavement - Item
Removal of Asphalt-Treated Base - Item
Removal of Cement-Treated Base - Item
Removal of Concrete Base - Item
Removal of Asphalt Pavement, Partial-Depth - Item
Removal of Asphalt Pavement from Concrete Surfaces on Structures - Item
Removal of Concrete Pavement, Partial-Depth
Removal of Concrete - Item
Preparing Right-of-Way - Item
Removal of Driveways, Sidewalks, and Sundry Asphalt Pavements - Item
Removal of Concrete Sidewalk - Item
Removal of Gabions - Item
Removal of Sign Support Structure - Item
Removal of Sign Support Structure Footings - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Imported backfill shall be paid for separately according to the tender item of the material specified in the Contract Documents.

Payment at the Contract price for the appropriate removal tender item shall be full compensation for all labour and Equipment for earth excavation required in the course of the removal operations.

Material designated for salvage but damaged by Contractor operations or lost by the Contractor shall be replaced with new material at no additional cost to the Owner.

If the Contractor elects to remove maintenance holes, catch basins, ditch inlets, and valve chambers in their entirety rather than as a partial removal, the removal shall be at no additional cost to the Owner.

When the Contract does not contain a separate item for the removal of pipe subdrain, pipes, culverts, force mains, or water mains, that interfere with the execution of the work, the contract price for the items requiring the removal of the pipe subdrain, pipes, culverts, force mains or water mains shall include full compensation for all labour, Equipment, and Materials required to do the work described in this specification.

Disturbed or damaged portions not designated for removal or salvage that result from the Contractor's operations shall be corrected or repaired at no additional cost to the Owner.

All costs associated with temporary ramping, including ramping material, shall be included in the item price for Removal of Asphalt Pavement, Partial-Depth.

510.10.02 Excavation for Underpavement Objects

When the Contract contains separate items for the removal of concrete pavement, asphalt pavement, concrete base, cement-treated base, sidewalk, and curb and gutter, such items removed because of the removal of under-pavement objects such as sewers, culverts, Utilities, and watermains, payment shall be at the Contract prices and according to the specifications for the removal of concrete pavement, asphalt pavement, concrete base, cement-treated base, sidewalk, or curb and gutter, respectively.

510.10.03 Excavation for Removal

When excavation for removal overlaps the excavation required for other work under the Contract, the overlapping excavation for the removal shall be paid for in accordance with the specification for other work.

No deductions shall be made to the quantities of concrete base, cement-treated base, sidewalk, curb and gutter, and any other structure or portion of structure where these items removed are included within the established lines of an excavation item measured for separate payment.

Appendix 510-A, November 2018
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Temporary ramping or protective measures may be required when pavement removal exposes underground structure covers.

- Items that are to be removed, abandoned, demolished, or salvaged. (510.07.01)

- Stockpiling requirements. (510.07.01)

- Requirements for work that is to be carried out in waterbodies or on waterbody banks. (510.07.01)

- For removal items,
  - Delivery locations for salvaged materials in excess to Contract requirements (510.07.01.03)
  - For bridge structures, specify the line and grade to which the structure is to be removed. (510.07.02.01)
  - Destination of modular bridge components. (510.07.02.02)
  - Approximate weight of the modular bridge to be removed. (510.07.02.02)
  - Management of modular bridge substructure materials. (510.07.02.02.01)
  - Delivery requirements for ramp closure gates. (510.07.05.05)
  - Temporary ramping requirements. (510.07.06.01)
  - For pavement, specify the depth of sawcut and identify the pavement type; thickness; size of reinforcement, if any; and management of materials. (510.07.06.02 and 510.07.06.03)
  - For partial-depth pavement, identify the average depth of the removal and management of materials. (510.07.06.05)

- Method of measurement for the partial-depth removal of asphalt or concrete pavement. (510.09.01.18)

The designer should determine if the following is required and, if so, specify it in the Contract Documents:

- Imported backfill. (510.07.01.04)

The designer should list in the Contract Documents existing drawings available, if any, for structures to be removed. (510.07.01)

The designer should determine if special restrictions or permits apply where work under the specification is required in waterbodies or on waterbody banks.

For the demolition of bridges, OPSS 510 does not place any restrictions on the Contractor in terms of methods or equipment to be used. Therefore, when it is foreseen that a demolition will require special requirements or safety precautions, the designer should include these requirements in the Contract Documents.

The designer should determine which removals are included under Earth Excavation and Grading. (510.10.03)

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The designer should ensure that the removal of asphalt from bridge decks is to be paid separately, when the entire bridge deck is removed and the asphalt cannot be mixed with concrete.

The designer should ensure that all items to be left in place are in accordance with environmental constraints and requirements.

Removed items may contain materials that may be subject to specific handling and disposal requirements (e.g., asbestos and slag). The designer should ensure that these requirements are included where such materials are known to exist.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 102.010	Removals, Legend
OPSD 710.010	Capping Existing Structures, Maximum 4.0 m Cover

CONSTRUCTION SPECIFICATION FOR RIP-RAP, ROCK PROTECTION, AND GRANULAR SHEETING

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511.08 **QUALITY ASSURANCE - Not Used**

511.09 **MEASUREMENT FOR PAYMENT**

511.10 **BASIS OF PAYMENT**

APPENDICES

511-A **Commentary**

511.01 SCOPE

This specification covers the requirements for the installation of rip-rap, rock protection, granular sheeting, and geotextile.

511.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be as specified in the Contract Documents.

511.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

511.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Material

OPSS 1004 Aggregates - Miscellaneous
OPSS 1860 Geotextiles

511.05 MATERIALS

511.05.01 Rip-Rap, Rock Protection, and Granular Sheeting

Rip-rap shall be according to OPSS 1004 and as specified in the Contract Documents.

Rock protection and granular sheeting shall be according to OPSS 1004.

511.05.02 Geotextile

Geotextile shall be nonwoven, Class II according to OPSS 1860, with an FOS of 75-150 µm, unless otherwise specified in the Contract Documents.

511.07 CONSTRUCTION

511.07.01 Excavation

Prior to placing any material, the area shall be excavated or filled or both to the lines and dimensions specified in the Contract Documents and fine graded to a uniform even surface.

511.07.02 Placing Material

511.07.02.01 General

Material shall be placed to the lines and dimensions specified in the Contract Documents.

When rip-rap or rock protection is being placed on slopes, the rock shall commence at the toe of the slope and progress up the slope.

When geotextile is specified in the Contract Documents, rip-rap, rock protection, and granular sheeting shall be placed in a manner so as not to damage the geotextile.

511.07.02.02 Rip-Rap

Rip-rap shall be placed in a set and stable manner, flat on the slope with the largest dimension parallel to the slope contours. The larger pieces of rip-rap shall be placed in the bottom courses. The rip-rap shall be laid closely so that a reasonable semblance of courses is achieved. Smaller pieces of rip-rap shall be used to fill the voids.

511.07.02.03 Rock Protection

Rock protection shall be placed in a random, but stable manner.

511.07.02.04 Granular Sheeting

Granular sheeting operations shall follow earth excavation operations as closely as practical and possible.

Compaction of granular sheeting material is not required.

511.07.02.05 Geotextile

Geotextile shall be free of folds, tears, and punctures and as specified in the Contract Documents. The geotextile shall be joined so that the material overlaps a minimum of 500 mm and shall be pinned together. Alternatively, the geotextile shall be joined to conform to the seam requirements of OPSS 1860.

Geotextiles shall be fixed to prevent movement during installation. Geotextile shall be wrapped down into the ground a minimum 300 mm at termination points.

511.07.03 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

511.09 MEASUREMENT FOR PAYMENT

511.09.01 Actual Measurement

511.09.01.01 Rip-Rap

Measurement of rip-rap shall be by area in square metres following the contour of the ground.

511.09.01.02 Rock Protection

Measurement of rock protection shall be by volume in cubic metres. The volume is a product of the area of the rock protection measured following the contour of the ground by its depth.

Truck box measurement shall be used when it is not possible to take an in place measurement.

511.09.01.03 Granular Sheeting

Measurement of granular sheeting shall be by area in square metres following the contour of the ground.

511.09.01.04 Geotextile

Measurement of geotextile shall be by area in square metres following the contour of the ground, without any allowance made for overlaps.

511.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

511.10 BASIS OF PAYMENT

511.10.01 Rip-Rap - Item
Rock Protection - Item
Granular Sheeting - Item
Geotextile - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

When there is not a separate tender item for geotextile, payment for the geotextile shall be included in the tender item for rip-rap, rock protection, or granular sheeting, as appropriate.

Appendix 511-A, November 2019
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Gradation requirements of rip-rap as per Tables 7 and 8 of OPSS 1004. (511.05.01)

- Use of alternate geotextile requirements for site or project specific applications. (511.05.02)

- Lines and dimensions for excavation of rip-rap, rock protection, or granular sheeting areas. (511.07.01)

- Lines and dimension for placement of material. (511.07.02.01)

- Geotextile locations, if required. (511.07.02.01)

- Placement requirements for geotextile. (511.07.02.05)

The designer should determine if fish and fish habitat are present when placement of rip-rap, rock protection, or gravel sheeting in a watercourse is being considered. When fish and fish habitat are present, the designer should consider other options such as bioengineering techniques in consultation with relevant experts.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 810.010	General Rip-Rap Layout for Sewer and Culvert Outlets
OPSD 810.020	General Rip-Rap Layout for Ditch Inlets

CONSTRUCTION SPECIFICATION FOR INSTALLATION OF GABIONS

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512.05 **MATERIALS**

512.06 **EQUIPMENT - Not Used**

512.07 **CONSTRUCTION**

512.08 **QUALITY ASSURANCE - Not Used**

512.09 **MEASUREMENT FOR PAYMENT**

512.10 **BASIS OF PAYMENT**

APPENDICES

512-A **Commentary**

512.01 SCOPE

This specification covers the requirements for the installation of gabions.

512.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

512.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

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Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

512.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 206	Grading
OPSS 490	Site Preparation for Pipelines, Utilities, and Associated Structures
OPSS 501	Compacting
OPSS 517	Dewatering of Pipeline, Utility, and Associated Structure Excavation
OPSS 805	Temporary Erosion and Sediment Control Measures

Ontario Provincial Standard Specifications, Material

OPSS 1004	Aggregates - Miscellaneous
OPSS 1430	Gabion Baskets and Mats
OPSS 1860	Geotextiles

ASTM International

D 7014 – 10	Standard Practice for Assembly and Placement of Double-Twisted Wire Mesh Gabions and Revet Mattresses

512.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Gabion means a gabion basket or a gabion mat filled with gabion stones.

512.05 MATERIALS

512.05.01 Gabion Baskets and Gabion Mats

Gabion baskets and gabion mats shall be according to OPSS 1430.

Gabion baskets shall be manufactured from galvanized steel wire mesh or PVC coated galvanized steel wire mesh as specified in the Contract Documents. When the type of mesh is not specified in the Contract Documents, the gabion baskets shall be manufactured from PVC coated galvanized steel wire mesh.

Gabion mats shall be manufactured from PVC coated galvanized steel wire mesh.

512.05.02 Gabion Stones

Gabion stones shall be according to OPSS 1004 and as specified in the Contract Documents.

512.05.03 Geotextile

Geotextile shall be non-woven, Class II according to OPSS 1860, with an FOS of 75-150 µm, unless otherwise specified in the Contract Documents.

512.07 CONSTRUCTION

512.07.01 Site Preparation

Site preparation shall be according to OPSS 490.

512.07.02 Dewatering

Dewatering shall be according to OPSS 517.

512.07.03 Temporary Erosion and Sediment Control Measures

Temporary erosion and sediment control measures according to OPSS 805 shall be implemented when gabions are placed in or along a watercourse.

512.07.04 Excavation, Bedding, and Backfill

Excavation for gabions shall be according to OPSS 206.

Corrective measures ordered by the Contract Administrator to rectify deficiencies caused by over-excavation shall be performed. Material placed in the over-excavated area shall be compacted to the density requirements of OPSS 501.

Bedding and backfill shall be as specified in the Contract Documents.

512.07.05 Assembly of Gabions

Gabions shall be installed at the locations and to the line, grade, and dimensions specified in the Contract Documents.

Gabions shall be assembled, fastened, installed, filled, and closed according to ASTM D 7014 and the manufacturer's instructions and as specified in the Contract Documents.

Gabions shall be assembled so that wire ends do not project outside the units on any exposed surface.

Gabion stones shall be placed in 0.33 m lifts for 1 m high gabions and 0.25 m lifts for 0.5 m high gabions. The fill layer shall never be more than 0.30 m higher than any adjoining cell. Gabion stones shall be placed in a manner as not to damage the wire mesh or the PVC coating on the wire or cause deformation of the gabion. Gabion stones shall be placed to minimize the voids between the stones. When specified in the Contract Documents, the front face of exposed wall surfaces shall be hand placed gabion stone to ensure a uniform appearance.

Prior to securing the lids on the gabion basket, the gabion basket shall be slightly overfilled by 25 to 50 mm of gabion stone in order to allow for settlement of the stone within the units.

512.07.06 Placing of Internal Connecting Wires

Internal connecting wires shall be installed according to ASTM D 7014 and the manufacturer's recommendations. When gabions are used as a channelling revetment, internal connecting wires are not necessary.

512.07.07 Securing Lids

When the gabion has been filled, the gabion lid shall be bent over until all lid edges coincide with the front and side edges of the gabion and shall be secured to the front and sides by wire according to ASTM D 7014 and manufacturer's instructions and as specified in the Contract Documents.

512.07.08 Geotextile

Geotextile shall be placed uniformly, free of folds, tears or punctures and as specified in the Contract Documents. The geotextile shall be joined so that the material overlaps a minimum of 500 mm and shall be pinned together. Alternatively, the geotextile shall be joined to conform to the seam requirements of OPSS 1860. Geotextile shall be fixed to prevent movement during installation.

512.07.09 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

512.09 MEASUREMENT FOR PAYMENT

512.09.01 Actual Measurement

512.09.01.01 Gabions

Measurement of gabions shall be by volume in cubic metres based on the nominal dimensions of the gabions used. When the gabion excavation overlaps excavation required for other work, the measurement shall be made as specified with no deduction for overlaps.

512.09.01.02 Geotextile

Measurement of geotextile shall be by area in square metres, in place, without any allowance made for overlaps.

512.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

512.10 BASIS OF PAYMENT

512.10.01 Gabions - Item
Geotextile - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Any costs associated with any unauthorized over-excavation shall be the Contractor's responsibility and at no additional cost to the Owner.

Appendix 512-A, November 2017
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Gradation requirements of gabion stone as per Table 8 of OPSS 1004. (512.05.02)

- Use of alternate geotextile requirements for site or project specific applications. (512.05.03)

- Bedding and backfill requirements. (512.07.04)

- Location, line, grade, and dimensions of gabions. (512.07.05)

- Additional assembly requirements. (512.07.07)

- Placement requirements for geotextile. (512.07.08)

The designer should determine which type of mesh is to be used for the gabion baskets and specify it in the Contract Documents. PVC coated gabion baskets are recommended in aggressive environment when road salt may be present and in aquatic and marine applications. (512.05.01)

For extremely fine grained soil, geotextile with an FOS of 50-100 µm should be specified. (512.05.03)

The designer should determine if the exposed wall surfaces require a uniform appearance. (512.07.05)

The designer should determine if gabion height limits are necessary, and if required, they should be specified in the Contract Documents.

When a gabion installation performs a retaining function (i.e., headwall, wingwall, retaining wall, or toe wall) and holds up an embankment, the designer should consult an Engineer.

The designer should review the expected design life of the gabion installation prior to specifying the product.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

CONSTRUCTION SPECIFICATION FOR DEWATERING

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517.04 **DESIGN AND SUBMISSION REQUIREMENTS**

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517.06 **EQUIPMENT - Not Used**

517.07 **CONSTRUCTION**

517.08 **QUALITY ASSURANCE - Not Used**

517.09 **MEASUREMENT FOR PAYMENT - Not Used**

517.10 **BASIS OF PAYMENT**

APPENDICES

517-A **Commentary**

517.01 SCOPE

This specification covers the requirements for the design, operation, and removal of a dewatering or temporary flow passage system to control water during construction, and the control of the water prior to discharge to the natural environment and sewer systems.

517.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be as specified in the Contract Documents.

517.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

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517.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 404	Support Systems
OPSS 407	New Maintenance Hole, Catch Basin, Ditch Inlet, And Valve Chamber Installation
OPSS 408	Adjusting Or Rebuilding Maintenance Holes, Catch Basins, Ditch Inlets, And Valve Chambers
OPSS 412	Forcemain Installation in Open Cut
OPSS 441	Watermain Installation in Open Cut
OPSS 492	Site Restoration Following Installation of Pipelines, Utilities, And Associated Structures
OPSS 510	Removal
OPSS 539	Temporary Protection Systems
OPSS 805	Temporary Erosion and Sediment Control Measures

517.03 DEFINITIONS

For the purpose of this specification, the definitions in OPSS 182 and the following definitions apply:

Associated Appurtenances mean as defined in OPSS 412 and OPSS 441.

Automatic Transfer Switch means an electrical device that automatically transfers power supply to a backup power source when there is an outage of the primary power source.

Cofferdam means as defined in OPSS 539.

Cut-Off Wall means a below grade wall that restricts groundwater flow and/or supports excavations, typically using soil-bentonite or cement-bentonite.

Design Flow Rate means the volume of water per unit of time expected to flow into the area of construction during or after the design storm event, and may include groundwater discharge.

Design Storm Return Period means the average number of years based upon probability, between the occurrences of a storm event of a certain severity or greater.

Dewatering System means the components required to control water to permit construction work to proceed under specified conditions, and may include a groundwater control system, impermeable barriers, pumps, and/or equipment to carry out unwatering.

Dewatering Operation means pumping, baling, temporary ditching, or vacuum removal of groundwater, rain water, melt water, stormwater, surface run-off, water pipe leakage from excavations and trenches or within sheeted cofferdams to improve the soil stability or for other construction purposes.

Groundwater Control System means sump pumps, oversized excavations with perimeter ditches, deep wells or well points or other systems used to lower the groundwater table.

Plug means an impervious, natural, or constructed drainage work that blocks water.

Sediment means soil particles detached from an earth surface by erosion.

Sediment Control Measure means a measure to remove sediment from water prior to discharge to the natural environment and sewer systems.

Structures means as defined in OPSS 407 and 408.

Surrounding Area means as specified by the Ministry of the Environment, Conservation and Parks (MECP) or as specified in the Contract Documents.

Temporary Flow Control Device means a material or a group of materials that are used to control water flow into and out of a temporary flow passage system and can include a plug.

Temporary Flow Passage System means temporary flow control devices, channels, pipes, and other materials used to convey or divert water past an area under construction.

Unwatering means the removal of ponded or flowing surface water.

Vegetated Discharge Area means a sloped, open area of land with existing vegetation suitable to prevent erosion.

517.04 DESIGN AND SUBMISSION REQUIREMENTS

517.04.01 Design Requirements

A dewatering or temporary flow passage system shall be designed to control water at the locations specified in the Contract Documents and at any other location where a system is necessary to complete the work.

The design of the system shall be sufficient to permit the work at each location to be carried out as specified in the Contract Documents.

The design shall meet the requirements of the Contract Documents, and where a waterbody is present, shall include channel and inlet and outlet protection measures as required to protect the environment in the event of system failure or the design flow rate being exceeded.

The design shall not include the use of embankments and/or structures in public use, either existing or to be constructed as part of the Work, to control or stop water flow, unless approved by the Contract Administrator.

The design shall not result in displacement or damage to property, buildings, structures, utilities and other facilities adjacent to the Working Area, including from drawdown related settlement or other groundwater related effects.

The system shall be designed to prevent soil loss or erosion where water is removed, pumped, or discharged. The system shall be designed to prevent basal heave or instability.

Where the system involves the taking of water from a waterbody, the design shall maintain the flow of water and the natural functions of the waterbody upstream and downstream of the work area, and shall not interfere with other uses of the water.

Temporary flow passage systems shall be designed, as a minimum, for a 2 year design storm return period or as specified in the Contract Documents, and groundwater discharge. A longer return period shall be used when determined appropriate for the work.

517.04.02 Submission Requirements

The submission of Working Drawings is only required for the dewatering system item and temporary flow passage system item locations specified in the Contract Documents. Other locations requiring a system do not require the submission of Working Drawings.

Three sets of Working Drawings shall be submitted to the Contract Administrator at least 7 Days prior to commencement of the dewatering system installation, for information purposes only. Prior to final approval of Working Drawings, the seal and signature of a design Engineer shall be affixed on the Working drawings, verifying that the drawings are consistent with the Contract Documents.

Where multi-discipline engineering work is depicted on the same Working Drawing and the design or design-checking Engineer or both are unable to seal and sign the Working Drawing for all aspects of the work, the drawing shall be sealed and signed by as many additional design and design-checking Engineers as necessary.

The following information and details shall be shown on the Working Drawings, where applicable:

a) Plans, Elevations, and Details

i. Type of system.
ii. Design parameters demonstrating adequacy of the system and equipment.
iii. Design flow rate(s).
iv. Plan location, description, and dimensions of system components, including dams, cofferdams, cut-off walls, temporary channels, pipes, culverts, sewers, groundwater control systems employing wells and/or well points, sedimentation basins, tanks, pumps, power supply, and standby equipment.
v. Method of management of pumped water and plan location of all dewatering discharge points.
vi. Profile drawings shall extend through and immediately beyond the limits of the system.
vii. Water elevations upstream and downstream of the system at design flow rate.
viii. Dam height or crest elevation, cofferdam depth and tip elevation, cutoff wall depth or base elevation, pipe invert elevations, depths of wells and wellpoints, pump intake elevation, and sedimentation basin depth or base elevation.
ix. Plan location, elevation, and dimensions of environmental protection measures.
x. Pipe type, size, and length, pump capacity, and tank capacity.
xi. Material and construction standards to be used for the work.
xii. Method for establishing and monitoring construction site groundwater levels.

xiii. Criteria and method of removal of the system.

b) Procedures for the system construction, operation, and maintenance, including daily start-up sequence where applicable, and operation shut down.

c) Procedures for the removal of the system, including the removal sequence, and well decommissioning.

d) Stand-by power or pumping system requirements and the use of automatic transfer switching, when required to protect the environment and the Work.

e) A copy of the Permit to Take Water issued by the MECP or confirmation of registration of water taking for construction dewatering, if a permit or registration is required by provincial regulation.

f) When applicable, a copy of the water taking report and discharge plan required by provincial regulation.

g) A copy of any necessary permits for the discharge of water to a sanitary sewer, or stormwater sewer system, stormwater pond, or other facility.

h) Calibration documentation for the flow metering system.

517.04.03 Preconstruction Survey

When a groundwater control system by wells or a well point system will be used, a condition survey of property and structures that may be affected by the work shall be carried out. The condition survey shall include the location and condition of adjacent properties, buildings, underground structures, water wells, Utilities, and structures, within the preconstruction survey distance specified in the Contract Documents from the groundwater control system. In addition, all water wells used as a supply of drinking water and located within the preconstruction survey distance specified in the Contract Documents from the groundwater control system shall be tested for compliance with Ontario Drinking Water Quality Standards.

Water wells within the preconstruction survey distance can be located using the website https://www.ontario.ca/environment-and-energy/map-well-records or its successor site.

Copies of the condition survey and water quality test results shall be submitted to the Contract Administrator prior to the operation of the groundwater control system.

517.07 CONSTRUCTION

517.07.01 General

Dewatering systems and temporary flow passage systems shall be constructed and operated according to the Working Drawings, where applicable.

When required, support systems shall be according to OPSS 404, and temporary protection systems shall be according to OPSS 539.

Temporary erosion and sediment control measures, including to control the discharge of water, shall be according to OPSS 805. Measures not specified in OPSS 805 shall be according to the Working Drawings. Temporary erosion and sediment control measures and cover material to protect exposed soils, as required by the Working Drawings, shall be installed as soon as is practical.

Stranded fish shall be managed as specified in the Contract Documents.

Unwatering shall be carried out as necessary.

Water suspected of being contaminated as indicated by visual or olfactory observations shall be reported to the Contract Administrator.

517.07.02 Dewatering

A continuous dewatering operation shall be provided to keep the excavation stable and free of water. The excavation shall be monitored to ensure it remains stable and free of water.

The dewatering system shall be maintained and the surrounding area monitored for impacts to items such as, but not limited to, settlement and ground water usage. Any impacts shall be immediately reported to the Contract Administrator.

When a stand-by power or pumping system or both are required, they shall be as specified in the Contract Documents, and shall be installed on-site.

The availability, location, and use of automatic transfer switching shall be as specified in the Contract Documents.

Dewatering shall be discontinued in a manner so that disturbance of any structure or pipeline is avoided.

517.07.03 Dewatering System

The dewatering system shall be continuously operational to control buoyancy forces until such forces can be resisted by backfill and structure self-weight, to keep excavations stable, to avoid erosion impacts from the release of accumulated water, and to keep the work area in the condition required to complete the associated work as specified in the Contract Documents.

The dewatering shall be discontinued in a manner that does not disturb any structure, pipeline, or flow channel. Operation of the dewatering system shall be shut down according to the procedures specified in the Working Drawings, where applicable.

517.07.04 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

517.07.05 Temporary Flow Passage System

517.07.05.01 General

Installation and removal of temporary flow passage systems shall be according to this subsection, and the Working Drawings if applicable.

The temporary flow passage system shall be revised or realigned as required by construction staging.

When a temporary flow passage system is to remain operational through a seasonal shutdown period, the Contractor shall be responsible for any maintenance or repair costs due to the temporary flow passage system during the seasonal shutdown period.

517.07.05.02 Activation

517.07.05.02.01 Outside of a Waterbody

Temporary flow passage systems outside of a waterbody shall be activated according to the following sequential steps:

a) The temporary flow passage system shall be constructed in its entirety, with upstream and downstream plugs separating the original waterbody channel and the temporary flow passage system remaining in place.

b) The downstream plug shall be opened to allow water into the temporary flow passage system and water pressure shall be allowed to equalize between the original waterbody channel and the temporary flow passage system.

c) The upstream plug shall be opened to allow water to flow through both the original waterbody channel and the temporary flow passage system.

d) A plug shall be installed in the original waterbody channel, at the inflow confluence of the original waterbody channel and the temporary flow passage system, to fully divert the water to flow through the temporary flow passage system.

e) A plug shall be installed in the original waterbody channel, at the outflow confluence of the temporary flow passage system and the original waterbody channel, to prevent backflow into the original waterbody channel.

517.07.05.02.02 Within a Waterbody

Temporary flow passage systems within a waterbody shall be activated according to the following sequential steps:

a) An upstream temporary flow control device shall be installed to divert water flow into the temporary flow passage system.

b) A plug shall be installed in the original waterbody, at the inflow confluence of the original waterbody channel and the temporary flow passage system, to fully divert the water to flow through the temporary flow passage system.

c) A plug shall be installed in the original waterbody, at the outflow confluence of the temporary flow passage system and the original waterbody, to prevent backflow into the original waterbody channel.

517.07.06 Discharge of Water

Water from dewatering and unwatering operations shall be directed to a sediment control measure and/or a vegetated discharge area 30 m away from waterbodies or as far away as practicable from the top of the bank of any waterbody, prior to discharge to the natural environment.

Protection of waterbodies and waterbody banks shall be according to the Contract Documents.

Equipment and materials shall not be used or stored in vegetated discharge areas.

The discharge of water to the natural environment shall not be directed across pavements, sidewalks, curb and gutter or similar hard surfaces except through appurtenances as specified in the Contract Documents.

517.07.07 Monitoring

The Contract Administrator shall be notified of any complaints and any action taken or proposed to be taken in response to complaints.

Daily external visual monitoring of the surrounding area and property and structures on the preconstruction survey, if applicable, for impacts such as settlement and erosion shall be completed. Any observed impacts shall be immediately reported to the Contract Administrator. When public safety, the environment, or property is impacted or potentially impacted, the design Engineer shall, without delay, make a full

assessment and direct changes to the system to eliminate impacts or potential impacts. Any changes shall be documented according to the System Amendments subsection.

When a groundwater control system is observed to negatively impact water supplies obtained from any adequate sources that were in use prior to groundwater control system operation, then water shall be supplied to the affected water users. The water shall be equivalent in quantity and quality to the normal water takings of the users. Supply shall continue until the negative impacts on the water supplies are removed, or until Contract Completion, whichever occurs first.

517.07.08 System Amendments

When displacement or damage to embankments and/or structures, or property adjacent to the Working Area, occurs due to the operation of the system, or soil loss or erosion occurs where water is removed, pumped, or discharged, the dewatering or temporary flow passage system design shall be amended to stop the displacement, damage, soil loss, or erosion.

When Working Drawings are required for the work, amendments shall be submitted to the Contract Administrator within 2 Business Days of the system being amended, on revised Working Drawings bearing the seal and signature of the design Engineer and design-checking Engineer.

517.07.09 Temporary Flow Passage System Deactivation

517.07.09.01 Outside of a Waterbody

Deactivation of temporary flow passage systems outside of a waterbody shall be according to the following sequential steps:

a) The downstream plug in the original waterbody channel shall be opened to allow water into the original waterbody channel and water pressure shall be allowed to equalize between the original waterbody channel and the temporary flow passage system.

b) The upstream plug in the original waterbody channel shall be opened to allow water to flow through both the original waterbody channel and the temporary flow passage system.

c) A plug shall be installed at the inflow confluence of the original waterbody channel and the temporary flow passage system, to fully divert the water to flow through the original waterbody channel.

d) A plug shall be installed at the outflow confluence of the original waterbody channel and the temporary flow passage system, to prevent backflow into the temporary flow passage system.

517.07.09.02 Within a Waterbody

Deactivation of temporary flow passage systems within a waterbody shall be according to the following sequential steps:

a) The downstream plug shall be removed.

b) The upstream plug shall be removed.

517.07.10 Removal

Dewatering and temporary flow passage system components shall be removed when no longer required. Removal of system components shall be according to the procedures specified on the Working Drawings, where applicable, and as specified in the Contract Documents.

Removal of temporary drainage work shall be according to OPSS 510.

Environmental protection measures and cut-off walls shall be removed, unless approved otherwise by the Contract Administrator.

Sedimentation basins and other excavations shall be backfilled with the original soil excavated, unless approved otherwise by the Contract Administrator. All disturbed areas shall be restored to an equivalent or better condition than existed prior to the commencement of construction.

Site restoration shall be according to OPSS 492.

517.10 BASIS OF PAYMENT

Payment at the Contract price for the appropriate tender items associated with dewatering and temporary flow passage system shall be full compensation for all labour, Equipment, and Material to do the work.

When the Contract contains separate items for work required by this specification, payment shall be at the Contract prices and according to the specifications for such work.

Appendix 517-A, November 2021
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer may consider including soil boring data, a geotechnical report, a subsurface report, or a soils report in the Tender Documents.

The designer should specify the following in the Contract Documents:

- Surrounding area. (517.03)
- Stand-by power or pumping capacity or both. (517.04.01)
- Dewatering or temporary flow passage system. (517.04.01)
- Sustainability of dewatering or temporary flow passage system. (517.04.01)
- Return period of temporary flow passage systems. (517.04.01)
- Dewatering or temporary flow passage system designed to meet contract requirements. (517.04.01)
- Location of dewatering system item and temporary flow passage system items. (517.04.01)
- Signature of a design Engineer. (517.04.02)
- Preconstruction survey distance. (517.04.03)
- All water wells used as a supply of drinking water and located within the preconstruction survey distance. (517.04.03)
- Managing stranded fish. (517.07.01)
- When required, stand-by power or pumping system or both. (517.07.02)
- Availability, location, and use of automatic transfer switching, based on site conditions, impacts, and risk assessment. (517.07.02)
- The dewatering system. (517.07.04)
- The discharge of water. (517.07.07)
- The removal of dewatering and temporary flow passage system. (517.07.11)

Due to the time required, the designer should consider obtaining the dewatering permit to avoid delays, and transfer the permit to the Contractor. (517.04)

Intensity-Duration Factor (IDF) curve location, site specific minimum return period, return period flow estimates, and other information can be accessed through the MTO IDF Curve Look up Tool on the Drainage and Hydrology page of MTO's website. The use of local IDF information may be more applicable.

The need for a specific dewatering scheme should be determined. If a specific dewatering scheme is necessary, it should be specified in the Contract Documents.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 219.100	Light-Duty Straw Bale Barrier
OPSD 219.110	Light-Duty Silt Fence Barrier
OPSD 219.120	Light-Duty Fibre Roll Barrier
OPSD 219.130	Heavy-Duty Silt Fence Barrier
OPSD 219.131	Heavy-Duty Wire-Backed Silt Fence Barrier
OPSD 219.150	Sandbag Barrier
OPSD 219.160	Fibre Roll Grade Breaks
OPSD 219.180	Straw Bale Flow Check Dam
OPSD 219.191	Fibre Roll Flow Check Dam
OPSD 219.200	Sandbag Flow Check Dam
OPSD 219.210	Temporary Rock Flow Check Dam V-Ditch
OPSD 219.211	Temporary Rock Flow Check Dam Flat Bottom Ditch
OPSD 219.220	Sediment Trap In Ditch
OPSD 219.230	Temporary Slope Drain For Sediment Trap
OPSD 219.231	Temporary Berm Barrier
OPSD 219.240	Sediment Trap for Dewatering
OPSD 219.260	Turbidity Curtain
OPSD 219.261	Turbidity Curtain Seam Detail

CONSTRUCTION SPECIFICATION FOR TEMPORARY PROTECTION SYSTEMS

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539-A **Commentary**

539.01 SCOPE

This specification covers the requirements for the design, construction, maintenance, monitoring, and removal of a temporary protection system made necessary by excavation, embankment construction, dewatering, or other work.

539.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

539.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

539.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 903 Deep Foundations
OPSS 904 Concrete Structures
OPSS 906 Structural Steel for Bridges
OPSS 942 Prestressed Soil and Rock Anchors

Ontario Provincial Standard Specifications, Material

OPSS 1350 Concrete - Materials and Production
OPSS 1601 Wood Material, Preservative Treatment, and Shop Fabrication

CSA Standards

S6-19 Canadian Highway Bridge Design Code

Ontario Ministry of Labour

Occupational Health and Safety Act, R.S.O. 1990, c.O.1, as amended

American Association of State Highways Transportation Officials (AASHTO)

AASHTO Guide Design Specification for Bridge Temporary Works, 2nd Edition with 2020 Interim Revisions

International Organization for Standardization/International Electrotechnical Commission (ISO/IEC)

17025-17 General Requirements for the Competence of the Testing and Calibration Laboratories

539.03 DEFINITIONS

For the purpose of this specification, the following definitions apply.

Anchor means:

a) A system consisting of prestressed tendons or non-prestressed rods installed in predrilled holes and encapsulated in grout or concrete. A system that derives its load carrying capacity in bond between the grout and concrete body and the surrounding soil or rock; or

b) A tie back to a deadman.

Bracing means the system of walers, struts, anchorages, and like members that connect frames, shores, or panels of a sheathing system to resist external pressures and to provide stability against lateral movement.

Certificate of Conformance means a form issued by an Engineer confirming that the specified components of the Work are in general conformance with the Contract Documents as shown in OPSF 539-1.

Cofferdam means a watertight enclosure.

Dredge Line means the exposed lower limit of the protection system.

Erector means a supervisory person that undertakes the construction of a protection system.

Protection System means the construction necessary to mechanically support existing or proposed work so that its function shall not be affected or construction necessary to support work such as open excavations during actual construction operations for safety and convenience.

Raker means a structural member inclined to the front of the shoring wall providing lateral support.

Shoring Wall means a structural wall consisting of wood, steel, or concrete or any combination of these materials that supports earth or rock and any structure, materials, Utilities, or other facility contained in or on the supported earth or rock mass.

539.04 DESIGN AND SUBMISSION REQUIREMENTS

539.04.01 Design Requirements

539.04.01.01 General

The protection system shall be designed for the performance level as specified in the Contract Documents.

Except for Owner designed protection systems, the Contractor shall be responsible for the complete detailed design of the protection system required to carry out the work as specified in the Contract Documents.

Protection systems that are not as specified in the Contract Documents shall be assigned an appropriate performance level for design by the design Engineer. The Contract Administrator shall review the performance level selected at the time of submission of the specified Working Drawings.

The geotechnical and foundation portions of the design shall be based on a method published in AASHTO Guide Design Specification for Bridge Temporary Works and in general conformance with CAN/CSA-S6. The design shall be appropriate for the specific site conditions. Design methods not meeting the AASHTO and CSA design specifications may only be used on this Contract, if approved by the Owner.

A protection system shall be designed to provide protection for excavations at the locations as specified in the Contract Documents and at any other location where the stability, safety, or function of an existing structure or Utility may be impaired by construction work.

The temporary slope geometry used to determine requirements of the protection system shall be according to the Occupational Health and Safety Act.

Performance levels for protection systems are as follows:

Performance Level	Maximum Angular Distortion	Maximum Horizontal Displacement
1a	1:1000	5 mm
1b	1:1000	10 mm
2	1:200	25 mm
3	1:100	50 mm

Where:

Angular Distortion = $\pm \Delta/H$

Δ = Horizontal displacement in mm at height H
H = Height in mm above dredge line to point of measurement or height above the nearest system restraining support.

When performance level 1a is specified, the bracing system shall be preloaded.

Where the bracing systems are preloaded, the effects of the preload shall not cause damage to adjacent facilities.

Protection systems with a face within a horizontal distance of 1/3H of any part of a structure foundation shall be designed for performance level 1a.

539.04.01.02 Designer Qualifications

The design Engineer and design-checking Engineer shall have demonstrated expertise for the work. As well, the design Engineer and design-checking Engineer shall have a minimum of 5 years experience in designing protection systems of similar nature and scope to the required work.

One person shall not perform both the design Engineer and design-checking Engineer roles for a protection system.

539.04.01.03 Design Assumptions

The design assumptions shall accurately represent the subsurface conditions prevalent at the site and shall be specific to the type of protection system used. The design shall address the subsurface conditions at the project site as specified in the Contract Documents.

539.04.01.04 Vertical and Horizontal Loadings

Vertical and horizontal design loadings used shall represent existing conditions and accepted design practice. Future loadings that are known and may affect the protection system during its useful life shall be considered.

539.04.02 Submissions

539.04.02.01 Working Drawings

The Contractor shall submit 3 sets of Working Drawings to the Contract Administrator at least 7 Days prior to commencement of the protection system installation, for information purposes only. Prior to making a submission, the seals and signatures of a design Engineer and a design-checking Engineer shall be affixed on the Working Drawings verifying that the drawings are consistent with the Contract Documents.

Where multi-discipline engineering work is depicted on the same Working Drawing and the design or design-checking Engineer or both are unable to seal and sign the Working Drawing for all aspects of the work, the drawing shall be sealed and signed by as many additional design and design-checking Engineers as necessary.

Prestressed anchor submissions shall be according to OPSS 942.

When other authorities are involved, 1 set of Working Drawings shall be submitted for each authority at least 5 weeks prior to the commencement of falsework construction. The requirements of each authority shall be satisfied prior to commencement of the protection system installation.

The Contractor shall have a copy of the Working Drawings at the site during protection system installation.

For protection systems that are not specified in the Contract Documents, the Contractor shall submit the Working Drawings for these systems to the Contract Administrator at least 3 weeks prior to the commencement of any construction.

The following information and details shall be shown on the Working Drawings:

a) Plans, Elevations, and Details

   i. Location of protection system and station limits.
   ii. Plan and elevation of shoring showing the extent of the protection system.
   iii. Details of the shoring system, including cross-sections.
   iv. Details of internal bracing.

b) Design Criteria

   i. Pressure diagrams including values of horizontal and vertical loads, dead load, and live load surcharge.
   ii. Design assumptions and parameters.
   iii. Anchor bond stresses.
   iv. Pile design.
   v. Anchor system stressing schedule specifying working loads, stressing loads, and lock in loads.
   vi. Details of preload, when required.
   vii. For protection systems not specified in the Contract Document, the performance level shall be designated.

c) Materials

i. Grade of structural steel and grade and species of structural wood.
ii. Concrete strengths.
iii. Grout strengths.
iv. Details of protection from rain and frost action.
v. Wood lagging and size.
vi. Mill certificates or test reports from an independent organization certified by the Standards Council of Canada certifying that the steel meets the requirements of the grade, where specified.
vii. Details of patented accessories, including load test data.

d) Installation Procedure

i. Installation sequence and procedure, including to the installation of piling, lagging, anchor systems, and rakers.

e) Monitoring Method

i. The proposed method of monitoring the performance of the protection system during installation and use. The method of monitoring shall be consistent with the requirements specified in the Quality Control subsection.

f) Removal of Protection System

i. The details of the procedures associated with the removal of the protection system indicating: method, sequence of work, and removal limits, except when the protection system is specified in the Contract Documents to be left in place.

539.04.02.02 Amendments to Protection Systems

Work shall not proceed on amendments to the protection system until the Contractor has received sealed and signed approval to proceed from the design Engineer and design-checking Engineer and has submitted a copy of the approval to the Contract Administrator.

Amendments to the protection system shall be submitted to the Contract Administrator on revised Working Drawings bearing the seal and signature of the design Engineer and design-checking Engineer.

539.04.02.03 Preconstruction Survey

Prior to commencing the work, the Contractor shall submit to the Contract Administrator, a condition survey of property and structures that may be affected by the work. The survey shall include the locations and conditions of adjacent properties; buildings; underground structures; Utility services; and structures, such as walls abutting the site within a horizontal distance of $2H_w$ from the face of the protection system, where H_w is the height of the wall from the ground surface to the dredge line.

539.04.02.04 Materials

539.04.02.04.01 Structural Steel

539.04.02.04.01.01 Mill Certificates

The Contractor shall submit to the Contract Administrator at the time of delivery 1 copy of the mill certificates, indicating that the steel meets the requirements for the appropriate standards for H-piles, tube piles, casings, and sheet piles.

Where mill test certificates originate from a mill outside Canada or the United States of America the Contractor shall have the information on the mill certificates verified by testing by a Canadian laboratory. The laboratory shall be certified by an organization accredited by the Standards Council of Canada to comply with the requirements of ISO/IEC 17025 for the specific tests or type of tests required by the material standard specified on the mill test certificate. The mill test certificates shall be stamped with the name of the Canadian testing laboratory and appropriate wording stating that the material conforms to the specified material requirements. The stamp shall include the appropriate material specification number, the date (i.e., yyyy-mm-dd), and the signature of an authorized officer of the Canadian testing laboratory.

For Contractor designed protection systems using previously used structural steel that a mill test certificate is not available and coupons have not been tested to verify the steel's material properties, a mill test certificate is not required when the yield strength specified on the Working Drawings does not exceed 250 MPa. If the yield strength specified exceeds 250 MPa, the Contract Administrator may request that the material be tested to confirm the material properties indicated on the Working Drawings. The costs of this testing shall be at the expense of the Owner if the test results indicate that the material is according to the Working Drawings, and at the expense of the Contractor if the test results indicate that the material is not according to Working Drawings.

539.05 MATERIALS

539.05.01 Wood

Wood shall be according to OPSS 1601.

Wood shall be of the size, grade, and species shown on the Working Drawings and shall be in sound condition, free from defects that may impair its strength. Wood lagging does not have to be grade-stamped.

539.05.02 Proprietary Shoring and Patented Accessories

Where proprietary shoring or patented accessories are to be used, the Contractor shall follow the manufacturers' recommendations for load carrying capacity. The recommended load carrying capacities shall be supported by test results from an accredited testing laboratory approved by the Owner.

539.05.03 Concrete

Concrete shall be according to OPSS 1350.

539.05.04 Other Materials

The design Engineer may consider other suitable materials when sufficient information is available to quantify the allowable design loads or when the manufacturer's recommendations regarding load carrying capacities are supported by test results from an independent organization accredited by the Standards Council of Canada.

539.07 CONSTRUCTION

539.07.01 General

The Contractor shall be responsible for the design, materials, construction, maintenance, monitoring, and removal of a temporary protection system.

The erector shall be experienced in the method of construction of protection systems. Such experience shall have been obtained within the preceding 5 years on projects of similar nature and scope to the required work.

Protection systems shall be built according to the specifications and the Working Drawings.
Piling shall be according to OPSS 903 and the Working Drawings.

Concrete construction shall be according to OPSS 904. Concrete shall be placed in the dry. Where cofferdams are used, they shall be sealed sufficiently to permit concrete to be placed in the dry.

The Contractor shall carry out dewatering, as required, to facilitate the installation of the protection system.

Tremie concrete shall be placed according to the requirements of OPSS 904.

Structural steel shall be according to OPSS 906 and the Working Drawings.

Prestressed anchors shall be supplied, installed, and stressed according to OPSS 942.

The protection system shall be protected from the detrimental effects of rain and frost action.

Material used in the protection system shall remain the property of the Contractor.

Loss of soil from behind the shoring shall be prevented during and following the installation of the lagging.

539.07.02 Removal of Protection Systems

Protection systems shall be removed from the right-of-way, unless otherwise specified in the Contract Documents.

Where protection systems are left in place, the top shall be removed to at least 1.2 m below the finished grade or ground level or at least 0.6 m below the streambed.

All disturbed areas shall be restored to an equivalent or better condition than existed prior to the commencement of construction.

539.07.03 Quality Control

539.07.03.01 General

In addition to the quality control measures instituted by the Contractor, the Contractor shall complete a preconstruction condition survey and monitor the protection system installation as specified herein, and as shown on the Working Drawings.

539.07.03.02 Inspection of Welds

The Contractor shall be responsible for visual inspection of all welds. Any required testing of welds shall be as specified by the design Engineer of the protection system.

539.07.03.03 Monitoring

539.07.03.03.01 General

Monitoring shall be conducted by a Registered Ontario Land Surveyor or an Engineer according to the program submitted with the Working Drawings.

The minimum requirements for monitoring shall include the survey measurements of scaled targets attached to the shoring wall at the elevations specified. The scaled targets shall be placed at a maximum spacing of 6 m with targets placed at the extreme ends and the targets distributed between the outer limits. The survey targets shall be monitored for horizontal displacement from the vertical at the frequency specified.

All test results, observations, and records, including the preconstruction survey, taken during construction and operation of the protection system shall be available on the site for review by the Contract Administrator.

If movement of the protection system is more rapid than is expected, or if movement approaches the allowable limit, the Contract Administrator shall be notified immediately and suitable measures shall be taken to ensure stability of the protection system and to ensure movement does not exceed the performance level specified in the Contract Documents.

539.07.03.03.02 Excavation Depths Less Than or Equal to Three Metres

The protection systems shall be monitored during construction. Readings shall be taken at the top of the protection system at each construction stage during the installation. After installation, the above readings shall be taken every two weeks.

The Contractor's Engineer or an assigned delegate, working under the responsibility of the Contractor's Engineer shall inspect the following Work:

a) Installation of the protection system, including excavation to dredge line.

b) Removal of the protection system.

539.07.03.03.03 Excavation Depths Exceeding Three Metres

The protection systems shall be monitored during construction. Readings shall be taken during installation of the protection system at the top, at each restraint point, at the dredge line, and halfway between the restraint points at each construction stage during the installation of the protection system. After installation, the above readings shall be taken weekly.

The Contractor's Engineer or an assigned delegate, working under the responsibility of the Contractor's Engineer shall inspect the following work:

a) Layout and extent of protection system.

b) Piling.

c) Installation of protection system, including excavation to dredge line.

d) Removal of protection system.

539.07.03.04 Inspection of Protection Systems

539.07.03.04.01 Excavation Depths Less Than or Equal to Three Metres

For protection systems to facilitate excavation depths less than or equal to 3 m and provided that surcharge loading due to vehicular traffic, construction equipment and materials, or other is beyond a horizontal distance defined by a 1H : 2V line projected from the dredge line at the face of the protection system to the roadway surface, The Contractor's Engineer or an assigned delegate, working under the responsibility of the Contractor's Engineer shall inspect and verify that the protection system was installed, monitored, and subsequently removed according to the Working Drawings and Contract Documents.

A Certificate of Conformance shall be submitted to the Contractor Administrator upon completion of the installation of the protection system.

A Certificate of Conformance shall be submitted to the Contractor Administrator upon completion of the removal of the protection system.

Should the traffic be within a horizontal distance defined by a 1H: 2V line projected from the dredge line at the face of the protection system to the roadway surface, the Certificate of Conformance requirements as specified in the Excavation Depths Exceeding Three Metres clause shall apply.

539.07.03.04.02 Excavation Depths Exceeding Three Metres

For protection systems to facilitate excavation depths that exceed 3 m or should traffic, construction equipment and materials, or other be within a horizontal distance defined by a 1H:1V line projected from the dredge line at the face of the protection system to the roadway surface.

The Contractor's Engineer or an assigned delegate, working under the responsibility of the Contractor's Engineer shall inspect and verify that the materials have been supplied and installed according to the Contract Documents. A Certificate of Conformance shall be submitted to the Contract Administrator upon completion of the installation of the materials.

The Contractor's Engineer or an assigned delegate, working under the responsibility of the Contractor's Engineer shall inspect and verify and that the protection system was installed, monitored, and subsequently removed according to the Contract Documents. A Certificate of Conformance shall be submitted to the Contract Administrator upon completion of the removal of the protection system.

539.07.04 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

539.10 BASIS OF PAYMENT

539.10.01 Protection System - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

When the Contract does not contain a separate item for protection systems, the Contract price for the items directly associated with the protection system shall include full compensation for all labour, Equipment, and Material to do the work described in this specification.

CERTIFICATE OF CONFORMANCE

Contract Number: ……

Contractor: ……..……

Location / Structure: ……..……..……

Work, Component(s)/Element, or Product: ……...……

……..

……..……

I, _____ (print name), P. Eng. _____ (Professional Engineers of Ontario License Number) certify that the above-noted part of work, component, or product have been constructed in conformance to the requirements of the Contract Documents.

Seal and Signature

Date_____

DISTRIBUTION: 1) Contractor
2) Contract Administrator or Project Manager File

OPSF 539-1 (March 2021)

Appendix 539-A, November 2021
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Protection system performance level. (539.04.01.01)

- Location of excavations requiring protection systems. (539.04.01.01)

- When another authority is affected by the Contractor's operation. (539.04.02.01)

Clauses 539.07.03.04.01 and 539.07.03.04.01 require the use of a Certificate of Conformance as shown on form OPSF 539-1. If a form other than OPSF 539-1 is to be used for submission purposes, the alternate form should be invoked by reference in the Contract Documents and the specification should be amended to remove reference to OPSF 539-1.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

CONSTRUCTION SPECIFICATION FOR INSTALLATION OF ELECTRICAL CHAMBERS

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602-A **Commentary**

602.01 SCOPE

This specification covers the requirements for the installation, adjustment, and rebuilding of electrical chambers.

602.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

602.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

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602.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 206	Grading
OPSS 401	Trenching, Backfilling, and Compacting
OPSS 402	Excavating, Backfilling, and Compacting for Maintenance Holes, Catch Basins, Ditch Inlets, and Valve Chambers
OPSS 403	Rock Excavation for Pipelines, Utilities, and Associated Structures in Open Cut
OPSS 404	Support Systems
OPSS 407	Maintenance Hole, Catch Basin, Ditch Inlet, and Valve Chamber Installation
OPSS 408	Adjusting or Rebuilding Maintenance Holes Catch Basins, Ditch Inlets, and Valve Chambers
OPSS 490	Site Preparation for Pipelines, Utilities, and Associated Structures
OPSS 491	Preservation, Protection, and Reconstruction of Existing Facilities
OPSS 517	Dewatering of Pipeline, Utility, and Associated Structure Excavation
OPSS 609	Grounding
OPSS 610	Removal of Electrical Equipment and Materials
OPSS 904	Concrete Structures
OPSS 905	Steel Reinforcement for Concrete

Ontario Provincial Standard Specifications, Material

OPSS 1004	Aggregates - Miscellaneous
OPSS 1010	Aggregates - Base, Subbase, Select Subgrade, and Backfill Material
OPSS 1103	Emulsified Asphalt
OPSS 1301	Cementing Materials
OPSS 1302	Water
OPSS 1350	Concrete - Materials and Production
OPSS 1351	Precast Reinforced Concrete Components for Maintenance Holes, Catch Basins, Ditch Inlets, and Valve Chambers
OPSS 1440	Steel Reinforcement for Concrete
OPSS 1801	Corrugated Steel Pipe (CSP) Products
OPSS 1850	Frames, Grates, Covers, and Gratings
OPSS 2401	Electrical Handholes

CSA Standards

C22.2 No. 42-10 (R2015)	General Use Receptacles, Attachment Plugs and Similar Wiring Devices
C83-96 (R2016)	Communication and Power Line Hardware
G164-M92 (R2003)	Hot Dip Galvanizing of Irregularly Shaped Articles

ASTM International

A 48/A 48M-03 (2016)	Grey Iron Castings

Bureau de Normalisation du Quebec (BNQ)

3624-115-2007-05-04	Polyethylene (PE) Pipe and Fittings - Flexible Pipes for Drainage - Characteristics and Test Methods

602.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Electrical Chamber means a structure or chamber for placing and maintaining conductors, cables, ducts, or electrical equipment. Electrical chamber is a general name for electrical maintenance holes and handholes.

Rock means as defined in OPSS 206.

602.05 MATERIALS

602.05.01 Concrete

Concrete for cast-in-place electrical maintenance holes shall be according to OPSS 1350 with a nominal 28-Day compressive strength of 30 MPa.

602.05.02 Steel Reinforcement

Steel reinforcement shall be according to OPSS 1440.

602.05.03 Sand Bedding

Sand bedding shall consist of sand conforming to the gradation requirements of mortar sand according to OPSS 1004.

602.05.04 Precast Concrete Electrical Maintenance Holes

Precast concrete electrical maintenance holes shall be according to OPSS 1351 and the Contract Documents. The requirement for a Prequalification Certificate issued under the Plant Prequalification Program stated in OPSS 1351 does not apply to precast concrete electrical maintenance holes.

602.05.05 Electrical Handholes

Electrical handholes shall be according to OPSS 2401 and the Contract Documents.

602.05.06 Steps

Steps for electrical maintenance holes shall be according to OPSS 1351.

602.05.07 Adjustment Units

Precast adjustment units shall be according to OPSS 1351 and as specified in the Contract Documents.

602.05.08 Frames with Covers

Maintenance hole frames with covers shall be according to OPSS 1850 and the Contract Documents.

Frames with covers for handholes shall be cast ferrous alloy according to ASTM A 48, Class No. 30 C, and the Contract Document.

602.05.09 Pulling Irons

Pulling irons for cast-in-place maintenance holes shall be galvanized wrought steel according to CSA C83, Item C83.48.

Pulling irons for precast concrete maintenance holes shall be 20 mm diameter, 200 mm long galvanized steel straight thimble eye bolts with heavy square nuts, and 100 x 100 x 10 mm square washers according to CSA C83, Items C83.65 and C83.30, No. 3.

602.05.10 Drain Pipe and Fittings

Drain pipe and fittings shall be 100 mm diameter non-perforated, corrugated high density polyethylene, according to BNQ 3624-115.

Plugs shall be polyethylene according to C22.2 No. 42.

Corrugated steel end sections and fittings shall be according to OPSS 1801.

Rodent gates shall be galvanized according to CSA G164.

602.05.11 Mortar

Mortar shall consist of a mixture of one part Portland cement according to OPSS 1301 and two parts mortar sand according to OPSS 1004, wetted with sufficient water to make the mixture plastic. Water shall be according to OPSS 1302. Air entrainment shall be 12%.

602.05.12 Waterproofing

Waterproofing material shall be emulsified asphalt, anionic slow-setting type according to OPSS 1103.

602.05.13 Grounding Materials

Grounding materials shall be according to OPSS 609.

602.05.14 Granular Material

Granular material for bedding and backfill shall be according to OPSS 1010.

602.05.15 Flexible Utility Marker

Flexible utility marker shall be according to the Contract Documents.

602.07 CONSTRUCTION

602.07.01 General

General requirements for electrical work shall be as specified in the Contract Documents.

Electrical chambers of the type specified in the Contract Documents shall be installed on firm foundations at the locations and to the elevations specified in the Contract Documents and shall be constructed plumb and true to alignment.

The top of structures shall be installed below the final grade to allow for the placing of adjustment units to facilitate the placing of the top of the frame with grate or cover to the final grade.

Flexible utility markers for electrical chambers shall be installed at locations specified in the Contract Documents.

602.07.02 Removals

Removals shall be according to OPSS 610.

602.07.03 Site Preparation

Site preparation shall be according to OPSS 490.

602.07.04 Preservation and Protection of Existing Facilities

Preservation and protection of existing facilities shall be according to OPSS 491.

602.07.05 Cold Weather Work

All work shall be protected from freezing. Structures shall not be installed on frozen ground.

602.07.06 Transporting, Unloading, Storing, and Handling Materials

Manufacturer's recommendations for transporting, unloading, storing, and handling of materials shall be followed.

Materials that are unsound or damaged shall be rejected.

602.07.07 Excavating, Backfilling, and Compacting

Excavating, backfilling, and compacting for the installation of electrical chambers shall be according to OPSS 402.

Earth shall be excavated to accommodate at least 300 mm of granular backfill around the outer walls of the unit. When specified in the Contract Documents, a drainage pocket or drainage facilities lower than the electrical chamber floor shall be excavated and backfilled with 19 mm clear crushed rock.

Earth shall be excavated for separate drainage pockets and drain pipes as specified in the Contract Documents.

Backfill around the walls of units shall be according to OPSS 402, except that acceptable native material may be used when any part of the electrical chamber is 1.5 m or more beyond the outside edge of the shoulder.

Backfill for electrical chambers installed in grassed areas shall be native backfill.

Granular backfill or unshrinkable backfill, or material approved by the Contract Administrator shall be used for electrical chambers within 1.5 m of the outside edge of the shoulder.

602.07.08 Support Systems

Support systems shall be according to OPSS 404.

602.07.09 Dewatering

Dewatering shall be according to OPSS 517.

602.07.10 Electrical Chamber Drains

Drainage facilities shall be as specified in the Contract Documents.

The drain pipe shall be installed as specified in the Contract Documents and according to OPSS 401. Holes in electrical chamber drains shall be formed by core drilling or other approved methods.

Ends of cut steel bars shall be coated with epoxy paste and the drain pipe shall be mortared in place so that it does not protrude into the structure cavity.

The drain pipe shall have a formed trap in all cases when drainage is connected to a storm sewer system.

The drain pipe shall be provided with a 150 mm diameter corrugated steel end section and rodent gate in all cases when drainage is connected to an embankment slope or ditch is specified. The drain pipe shall be inserted at least 300 mm into the end section.

Drain pipes shall be laid in a trench between 300 and 400 mm wide, with a minimum grade of 400H 1V. Sand bedding and backfill of 150 mm each shall be placed when the drain pipe is installed in rock.

602.07.11 Installation

602.07.11.01 Electrical Maintenance Holes

Maintenance holes shall be oriented so that ducts and duct bank entries have an angle of 90° between the maintenance hole wall and the axis of the ducts and duct bank. If this is not possible, the angle shall not be less than 45°.

Maintenance holes shall be oriented so that maintenance hole steps are placed on the maintenance hole wall nearest to the travelled edge of pavement.

All inside wall protuberances shall be ground smooth prior to installation of wiring baffles and mechanical supports for cables.

All liquid and debris shall be cleaned from the electrical chambers upon completion and prior to the acceptance of work by the Contract Administrator.

When the Contract Documents specify that a maintenance hole is to be constructed on existing runs of rigid duct, either direct buried, in steel liner, or concrete encased; the ducts, concrete encasement, reinforcing steel, and steel liners shall be cut back and removed to suit the maintenance hole dimensions. The Contractor may,

a) construct a cast-in-place electrical maintenance hole around the duct structure and modify the duct after placing the maintenance hole, or

b) cut the duct structure back to a minimum of 300 mm beyond the outer maintenance hole walls, install a precast unit, and reinstate ducts into the maintenance hole.

Pulling irons shall be mounted on all maintenance hole walls opposite to the rigid duct entry and, when specified in the Contract Documents, in the floor of the units, and centred under the cover opening. Pulling irons shall be installed as specified in the Contract Documents and before waterproofing the unit. When pulling irons are installed after concrete has been poured, a 22 mm diameter hole shall be drilled in the wall and an eyebolt installed with a square washer and nut on each side of the wall.

602.07.11.01.01 Precast Electrical Maintenance Holes

Precast maintenance holes shall be supplied to the depth specified in the Contract Documents or to the depths necessary to accommodate the depths of ducts, duct banks, or cable required to enter the precast unit. When the vertical location of ducts are adjusted for Utility clearance or drainage and a deeper maintenance hole is required, the additional depth may be obtained by additional courses of brick or precast adjustment units up to 255 mm depth.

Precast maintenance holes shall be installed on a level surface and then backfilled and compacted to maintain the specified unit plumb and true to the required alignment and grades.

Precast or mono bases shall be placed level. Subsequent sections, complete with joint seal systems, shall be installed according to the manufacturer's recommendations.

During installation, all duct openings and drainage facilities shall be fitted to the required orientation and location and all segmental sections, gaskets, and PVC waterstops shall be firmly seated.

Adjustment of the structure shall be carried out by lifting the affected sections free of the excavation, re-levelling the base, if necessary, and re-installing the sections. Damaged sections and gaskets shall be replaced.

Lift holes shall be plugged with mortar.

602.07.11.01.02 Cast-In-Place Electrical Maintenance Holes

Cast-in-place maintenance holes shall be cast plumb and true to the alignment and grades specified in the Contract Documents.

Concrete shall be placed, cured, protected, and finished according to OPSS 904. Steel reinforcement shall be placed according to OPSS 905.

Formwork for duct openings shall be accurately located to the dimensions specified in the Contract Document and shall consist of either non-metallic or removable forms. Ducts, duct banks, duct end bells, and liners shall be set in the framework prior to pouring concrete and shall be installed to provide an opening for later installation of these items.

602.07.11.02 Electrical Handholes

Electrical handholes shall be cast-in-place concrete handholes, precast concrete handholes, or prefabricated handholes made of semi-concrete or non-concrete materials.

Electrical handholes shall be installed plumb, true to alignment and grade, and firmly bedded on the drainage pocket backfill.

During installation, the duct entry holes shall be oriented in the required direction. The enlarging of duct entry holes is prohibited.

602.07.11.02.01 Cast-In-Place Concrete Electrical Handholes

Formwork for cast-in-place electrical handholes shall be secured to form a concrete envelope of uniform wall thickness and shall be set plumb and firmly bedded on the drainage pocket backfill. The cast iron frame and all ducts shall be installed in the formwork prior to pouring concrete.

Concrete shall be poured, cured, protected, and finished according to OPSS 904.

Outside formwork shall be removed to at least 150 mm below finished grade.

602.07.12 Duct Entry Holes

Duct entry holes shall be provided in the walls of electrical chambers in the orientation and number specified in the Contract Documents.

Any unused duct entry holes shall be firmly plugged from the inside with plastic plugs or, when waterproofing is specified, with mortar to the full thickness of the concrete walls.

When concrete encased duct banks are installed in maintenance hole units, the steel reinforcement of the duct bank shall be inserted 75 mm into the maintenance hole wall. The duct bank encasement shall be completely surrounded and bonded to the concrete wall. When direct buried rigid ducts, rigid ducts by subsurface installation or steel liners are installed in maintenance hole units, they shall be completely surrounded with concrete or grouted in place with mortar to the full thickness of the maintenance hole wall.

602.07.13 Grounding

Grounding shall be according to OPSS 609.

Metal cable racks and maintenance hole frames shall be connected to the system ground wire. When a ground rod is required at a maintenance hole, the system ground wire shall exit and re-enter the maintenance hole to enable ground rod connection as specified in the Contract Documents.

Grounding for handhole and maintenance hole covers shall be as specified in the Contract Documents.

602.07.14 Waterproofing

When specified in the Contract Documents, waterproofing material shall be applied to the outside walls, top, and adjustment units of concrete electrical chambers. For precast electrical chambers, the underside of the floor slab shall have a similar application. For cast-in-place electrical chambers, 300 µm polyethylene sheeting shall be installed between the underside of the floor and the bedding prior to pouring concrete. All holes not used shall be grouted with mortar.

Waterproofing material shall be applied at the rate of 0.8 L/m^2 of surface.

602.07.15 Installation of Adjustment Units

The installation of precast adjustment units shall be according to OPSS 407 and as specified in the Contract Documents.

602.07.16 Installation of Frames and Covers

Frames with covers shall be installed according to OPSS 407 and as specified in the Contract Documents.

Maintenance hole covers and gaskets shall be secured as specified in the Contract Documents.

Cast iron frames for handhole covers shall be adjusted to the required elevation and crossfall. Mortar shall be used to smooth out any edges protruding above the concrete envelope.

Cast iron covers for handholes shall be secured as specified in the Contract Documents.

Covers for prefabricated handholes shall be firmly seated according to the manufacturer's instructions.

602.07.17 Adjusting and Rebuilding Electrical Chambers

The adjusting and rebuilding of existing electrical chambers shall be according to OPSS 408 and as specified in the Contract Documents.

602.07.18 Quality Control

602.07.18.01 Pre-Installation Testing and Inspection

Electrical chambers and chamber drain components shall be inspected prior to installation to ensure that they are according to the Contract Documents.

The Contractor shall submit to the Contract Administrator certification from the manufacturer that the product is according to the Contract Documents.

602.07.18.02 Pre-Installation Strength Testing of Semi-Concrete and Non-Concrete Handholes

Ten percent of the handholes shall be selected for strength testing. For each handhole selected, the handhole shall be placed on a flat surface with only the bottom of the handhole in contact with the ground. No external support shall be provided for the sides of the handhole. A weight of 2,000 kg shall be placed on top of the handhole for ten minutes. At the end of each test, the handhole shall be inspected. The handhole shall not exhibit any signs of cracking or deformation. If the handhole is deformed, cracked, or damaged in any way, it shall be considered failed and shall be replaced. If one or more handholes fail, then another 10% of the handholes shall be selected and tested. If one or more of those handholes fail, then all of the handholes shall be tested.

The Contractor shall submit the results of the strength testing to the Contract Administrator.

602.07.18.03 Electrical Chamber Installations

The Contractor shall ensure that the following are according to the requirements specified in the Contract Documents:

a) Properly seated and aligned to a plumb position.

b) Type of backfill.

c) Compaction of backfill.

d) All unused holes and spaces are filled.

e) Waterproofing has been correctly applied.

f) All frames and covers are secured and adjusted to grade.

602.07.19 Temporary Electrical Work

The work for temporary electrical installations shall be the same as for permanent installations of the same type of work, except that the work shall include the removal of the installations when they are no longer required.

602.07.20 Management of Excess Material

Management of excess material shall be as specified in the Contract Documents.

602.09 MEASUREMENT FOR PAYMENT

602.09.01 Actual Measurement

602.09.01.01 Electrical Maintenance Holes
Electrical Handholes

For measurement purposes, a count shall be made of the number of complete electrical chambers installed.

602.09.01.02 Adjusting and Rebuilding Electrical Chambers

For measurement purposes, a count shall be made of the number of electrical chambers adjusted or rebuilt.

602.09.01.03 Electrical Chamber Drains

Measurement of electrical chamber drains shall be by length in metres along the horizontal centreline of the drain pipe from the centre of the electrical chamber to the centre of the drainage pocket, storm sewer structure, storm sewer pipe, or concrete culvert or outlet end of the drain terminating at an embankment slope or ditch.

602.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

602.10 BASIS OF PAYMENT

602.10.01 Electrical Maintenance Holes - Item
Electrical Handholes - Item
Adjusting and Rebuilding Electrical Chambers - Item
Electrical Chamber Drains - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

602.10.02 Electrical Maintenance Holes, Temporary - Item
Electrical Handholes, Temporary - Item
Electrical Chamber Drains, Temporary - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Progress payment for temporary installation of above tender items shall be based on the following percentages of the Contract price:

80% for supply and installation

20% for removal

602.10.03 Rock Excavation for Trenches and Associated Structures

Payment for rock excavation for trenches and associated structures shall be according to OPSS 403.

Appendix 602-A, November 2017
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

Designer should specify the following in the Contract Documents:

- Type, location, and elevations of electrical chambers. (602.07.01)

- Flexible utility marker locations. (602.07.01)

- Precast electrical maintenance hole depths. (602.07.11.01.01)

- Alignment and grade of cast-in-place electrical maintenance holes. (602.07.11.01.02)

- Duct opening locations and dimensions in cast-in-place electrical maintenance holes. (602.07.11.01.02)

- Orientation and number of duct entry holes in electrical chambers. (602.07.12)

The designer should determine if the following are required and, if so, specify them in the Contract Documents:

- Drainage pockets and drain pipes. (602.07.07)

- Pull irons in the floor of maintenance holes. (602.07.11.01)

- Waterproofing of concrete electrical chambers. (602.07.14)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 704.010	Precast Concrete Adjustment Units for Maintenance Holes, Catch Basins, and Valve Chambers
OPSD 2111.020	Electrical Maintenance Hole, Precast Concrete, 600 mm x 1450 mm
OPSD 2111.030	Electrical Maintenance Hole, Precast Concrete, 1200 mm Dia.
OPSD 2111.040	Electrical Maintenance Hole, Precast Concrete, 1200 mm x 1650 mm
OPSD 2111.050	Electrical Maintenance Hole, Precast Concrete, 1800 mm x 2400 mm
OPSD 2112.010	Electrical Handhole, Precast Concrete with Cover, 300 mm Dia.
OPSD 2112.020	Electrical Handhole, Precast Concrete with Cover, 460 mm Dia.
OPSD 2112.030	Electrical Handhole, Precast Concrete - 675 mm Diameter
OPSD 2112.040	Electrical Handhole, Precast Concrete - 600 x 600 mm
OPSD 2112.050	Electrical Handhole, Precast Concrete with Cover, 300 x 500 mm
OPSD 2113.010	Electrical Handhold, Non and Semi-Concrete, General Requirements
OPSD 2116.010	Drainage Facilities for Electrical Maintenance Holes
OPSD 2116.020	Electrical Maintenance Hole, Drains to Drainage Pockets, Embankment Outlets, and Ditches
OPSD 2116.030	Electrical Maintenance Hole, Drains to Storm Sewer Systems

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OPSD 2117.010	Electrical Maintenance Holes, General Installation Requirements
OPSD 2117.020	Electrical Handholds, General Installation Requirements
OPSD 2118.010	Electrical Chamber, Installation in Median
OPSD 2118.020	Electrical Chamber, Installation in Slope
OPSD 2123.010	Electrical Maintenance Holes, Entry of Direct Buried Ducts
OPSD 2123.020	Electrical Maintenance Holes, Entry of Encased Ducts
OPSD 2123.030	Electrical Handholds, Entry of Direct Buried and Encased Ducts

CONSTRUCTION SPECIFICATION FOR INSTALLATION OF DUCTS

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603-A **Commentary**

603.01 SCOPE

This specification covers the requirements for the installation of flexible ducts, rigid ducts concrete encased, rigid ducts direct buried, rigid ducts by subsurface installation, rigid ducts steel encased by subsurface installation, and surface mounted duct systems. This specification also covers the requirements for rock excavation for all electrical work.

603.01.01 Specification Significance and Use

This specification has been developed for use in municipal-oriented Contracts. The administration, testing, and payment policies, procedures, and practices reflected in this specification correspond to those used by many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

603.01.02 Appendices Significance and Use

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OPSS 401	Trenching, Backfilling, and Compacting
OPSS 492	Site Restoration Following Installation of Pipelines, Utilities, and Associated Structures
OPSS 501	Compacting
OPSS 610	Removal of Electrical Equipment and Materials
OPSS 905	Steel Reinforcement for Concrete

Ontario Provincial Standard Specifications, Material

OPSS 1004	Aggregates - Miscellaneous
OPSS 1301	Cementing Materials
OPSS 1302	Water
OPSS 1350	Concrete - Materials and Production
OPSS 1359	Unshrinkable Backfill
OPSS 1440	Steel Reinforcement for Concrete
OPSS 1802	Smooth Walled Steel Pipe

CSA Standards

B137.1-20	Polyethylene (PE) Pipe, Tubing, and Fittings for Cold-Water Pressure Services
C22.2 No. 45.1-07 (R2017)	Electrical Rigid Metal Conduit - Steel
C22.2 No. 211.1-06 (R2016)	Rigid Types EB1 and DB2/ES2 PVC Conduit
C22.2 No. 211.2-06 (R2016)	Rigid PVC (Unplasticized) Conduit
C22.2 No. 227.1-19	Electrical Nonmetallic Tubing
C22.2 No. 2515-19	Aboveground Reinforced Thermosetting Resin Conduit (RTRC) and Fittings

ASTM International

F2160-16 Standard Specification for Solid Wall High Density Polyethylene (HDPE) Conduit Based on Controlled Outside Diameter (OD)

Underwriters Laboratories (UL)

UL 651A - 10/26/2011 Type EB and Rigid PVC Conduit and HDPE Conduit

National Electrical Manufacturers Association (NEMA)

TC 7 - 2016 Smooth-Wall Coilable Electrical Polyethylene Conduit

Electrical Safety Authority (ESA)

Ontario Electrical Safety Code – 2018

603.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Junction Boxes means surface mounted or embedded boxes for use with electrical wirings or devices.

Horizontal Directional Drilling (HDD) means directional boring or guided horizontal boring.

Rock means as defined in OPSS 206.

603.05 MATERIALS

603.05.01 Concrete

Concrete shall be according to OPSS 1350 with a nominal 28-Day compressive strength of 20 MPa.

603.05.02 Steel Reinforcement

Steel reinforcement shall be according to OPSS 1440.

603.05.03 Sand Bedding

Sand bedding shall consist of sand conforming to the gradation requirements of mortar sand according to OPSS 1004.

603.05.04 Fish Line and Trace Wire

Fish line shall be nylon or polypropylene material with a minimum test strength of 400 N. Trace wire shall be minimum #12 AWG copper wire, green insulation.

603.05.05 Steel Liner

Steel liner shall be according to OPSS 1802.

603.05.06 Mortar

Mortar shall consist of a mixture of one part Portland cement according to OPSS 1301 and two parts mortar sand according to OPSS 1004, wetted with sufficient water to make the mixture plastic. Water shall be according to OPSS 1302. Air entrainment shall be 12%.

603.05.07 Unshrinkable Backfill

Unshrinkable backfill shall be according to OPSS 1359.

603.05.08 Ducts and Fittings

Ducts and fittings shall be according to the applicable standards shown in Table 1.

For surface mounted duct systems when runs of ducts exceed 50 m, rigid ducts and fittings shall be of regular wall thickness with watertight reinforced thermosetting resin conduit (RTRC) duct. Hanger support systems shall consist of galvanized steel supports and fibreglass tubular spacers with galvanized steel hardware. Support systems shall allow for multiple sizes of duct in each horizontal layer.

For surface mounted duct systems when runs of ducts are 50 m and under, they shall be rigid polyvinyl chloride (PVC) conduit or rigid galvanized steel conduit.

Ducts for HDD shall be solvent-free, mechanical spline connected with hydraulic seal, and rigid PVC ducts certified to CSA C22.2 No. 211.2.

603.05.09 Marker Tape

Marker tape shall be 75 mm wide polyethylene (PE) or copolymer material, colour red, with repeating black lettering “Caution - Buried Electric Line” or a similar message.

603.05.10 Concrete Anchors

Concrete anchors for surface mounted duct systems shall be of the epoxy resin system type when runs of ducts exceed 50 m. When runs are 50 m or less, the anchors shall be either of the epoxy resin type or metal expansion anchors. Each anchor shall have a minimum pullout strength of 60 kN for an embedment depth of 200 mm or less.

603.07 CONSTRUCTION

603.07.01 General

General requirements for electrical work shall be as specified in the Contract Documents.

Ducts shall be installed as specified in the Contract Documents.

Ducts for communication cables shall be installed in trenches with varying depth so that drainage is provided. A minimum depth of cover of 450 mm may be used in flat terrain in order to ensure that the ducts slope towards a maintenance hole. When the terrain allows natural drainage due to its slope, the depth of cover shall be 550 mm.

Non-metallic ducts installed and used when exposed to direct rays of the sun shall be specifically approved for the purpose and be marked (e.g., “SR,” “Outdoor,” “RTRC Type AG”) according to the Ontario Electrical Safety Code.

Wobble joint fittings with expanded polystyrene bedding or black bubble wrap shall be installed when direct buried rigid ducts terminate at concrete structures above the frost line such as electrical maintenance holes, footings, bridge structures, retaining walls, and duct banks.

603.07.02 Protection During Construction

When ducts are installed prior to placing roadbed granular materials, the ducts shall be protected with a minimum cover of 300 mm of compacted backfill material.

603.07.03 Removals

Removals shall be according to OPSS 610.

603.07.04 Locating Existing Ducts

The Contractor shall locate all existing ducts requiring modification or usage.

603.07.05 Excavation

603.07.05.01 General

Trenches shall be excavated to the widths, depths, and alignment as specified in the Contract Documents. Such dimensions may be adjusted to obtain proper clearances with Utilities or other works.

The trench bottom shall be free of sharp rock fragments or debris and uniformly graded to support the ducts.

603.07.05.02 Earth Excavation

When unsuitable earth material is encountered in the trench bottom, it shall be removed and replaced with suitable material, as directed by the Contract Administrator.

The trench bottom shall be undisturbed earth or suitable imported material compacted according to OPSS 501.

When trenches are to be constructed prior to the completion of final grades, the Contractor may excavate trenches to give a minimum temporary cover of 300 mm for the ducts.

603.07.05.03 Rock Excavation for Electrical Installations

Rock excavation for the installation of ducts shall be according to OPSS 206.

603.07.06 Flexible Ducts

Flexible ducts shall be laid loosely in the trench to allow for expansion and contraction. Ducts shall be installed free of kinks or flattening and without sharp objects in the trench.

Couplings used for flexible ducts made of PE shall be PVC serrated couplings or shall consist of a 450 mm piece of the duct, one size larger than the flexible duct, slotted, and centred over the butted joint and securely fastened using stainless steel strapping. When PE pipe is used, pulling points for cable shall be similarly constructed.

For the PE flexible ducts for communication fibre-optic cable, installation of runs between maintenance holes up to 120 m in length shall be done with a single run of non-spliced duct. For runs up to 240 m in length, one splice is allowed. For runs exceeding 240 m, one splice per 120 m maximum is allowed. Such duct splices shall be fully waterproofed using silicon sealant and plasticized waterproofing sealant and shall be inspected by the Contract Administrator prior to backfilling.

Couplings used for flexible ducts made of electrical non-metallic tubing (ENT) shall be according to manufacturer's drawings or instructions. When ENTs are used, pulling points for cable shall be at the electrical chambers.

High density polyethylene (HDPE) couplings shall be used for HDPE duct and shall be according to manufacturer's drawings or instructions. When HDPE ducts are used, pulling points for cable shall be at the electrical chambers.

Flexible ducts shall be installed so that stacking or crossovers within the trench are not required, except for the purpose of entering concrete encased rigid ducts or electrical chamber sleeves.

Flexible ducts shall be installed within all underpavement crossings not having an electrical chamber on each end.

At direct buried poles, flexible ducts shall be inserted into the wiring aperture and turned up to within 450 mm of the pole handhole.

At concrete footings for base mounted poles, flexible ducts shall be inserted through the sleeves to at least 750 mm above the foundation.

At entries to pad mounted substations and to pad mounted traffic signal controllers, flexible ducts shall be installed within the sleeves and cut off flush with the top of the sleeves. The void between the duct and the sleeve shall be sealed with an electrical sealant for pad mounted controllers.

When it is required to join flexible ducts with rigid ducts, serrated adapter couplings shall be installed.

When flexible ducts are brought into electrical chambers, the ducts shall remain free in the entry holes of handholes and grouted into entry holes of maintenance holes.

When flexible ducts are specified in the Contract Documents, the Contractor shall have the option of using rigid ducts of the same inside diameter.

603.07.07 Rigid Ducts, Concrete Encased

Plastic spacers, suitable to the size and type of ducts and the duct separation specified in the Contract Documents, shall be installed along the trench bottom at 1.5 m maximum intervals. When transitions in grade are required, the trench bottom shall be adjusted to allow the spacers to seat firmly and hold any required duct bends.

Steel reinforcement shall be installed according to OPSS 905. Rods shall overlap by at least 60 mm and shall be tied to the plastic spacers. Lengths of duct shall be connected using couplings suitable to the size and type of duct. Couplings shall be staggered to obtain a minimum of 50 mm clearance between ducts or couplings. Ducts shall be tied to the spacers. The assembly shall be anchored securely to prevent shifting during placing of concrete.

Concrete may be poured directly into the trench or form work installed along the sides of the duct bank. The method of transporting, placing, and consolidating the concrete shall be such as to prevent segregation. Concrete placing and transporting devices shall not be supported by the steel reinforcement. Concrete shall be deposited within 1.5 m of its final position. Chutes shall have sufficient slope to deliver concrete of the approved consistency and shall have a maximum length of 15 m. When concrete is to be dropped more than 1.5 m, fully enclosed vertical drop chutes extending to the point of deposit shall be used. Concrete shall be placed at a steady rate such that a monolithic concrete is obtained without the formation of cold joints. The finish shall be raked or trimmed to produce a flat surface.

Rigid ducts shall be installed with a minimum slope of 400H:1V. Where deviations in vertical grade are required to avoid Utilities or other works, ducts shall be installed so that water cannot accumulate in the ducts.

Except where connections to electrical maintenance holes are required, rigid ducts and casing crossing paved areas shall extend 1.0 m beyond the back face of the curb or to the back edge of the shoulder.

When it is required to install transition sections between different types of rigid duct installations, the Contractor shall use deflection couplings or bend the ducts as required over a maximum of two standard duct lengths to obtain the required configuration.

603.07.08 Rigid Ducts, Direct Buried

The trench bottom shall be shaped and uniformly graded to support the entire duct. Lengths of duct shall be connected using couplings suitable to the size and type of duct supplied.

603.07.09 Flexible and Rigid Ducts by Subsurface Installation

Pits required for subsurface installation operations shall be set back a minimum distance from the edge of pavement or back of curb so that excavation is not done within a 1H:1V slope from the edge of pavement or back of curb to the bottom of the pit.

Bore holes shall only be 50 mm larger in diameter than the rigid duct being installed. When rigid ducts are being installed using the push-pull method, the steel rod shall be accurately aligned and pushed through the target pit. The push cap shall be replaced by a suitably sized expander unit and pulled back to the operating pit.

Lengths of duct shall be connected using couplings suitable to the size and type of duct supplied.

All temporary piling or supports used for boring or jacking equipment shall be removed or cut off to a minimum of 1.0 m below finished grade. All excavations or holes shall be backfilled and all temporary fill shall be removed.

When steel encasements are being installed using the boring and jacking method, the steel encasement shall be advanced so that the bore hole wall is supported by the steel encasement to within 300 mm of the head of the auger.

For HDD method, no drilling pit is required. Installation shall be according to the HDD machinery and duct manufacturers' guidelines and recommendations.

603.07.10 Surface Mounted Duct Systems

The Contractor shall not drill through bridge reinforcing steel. The Contractor shall locate reinforcing steel with a cover meter and position anchors accordingly.

For surface mounted duct systems, when the runs exceed 50 m horizontally:

a) The installation of the support systems and ducts shall be carried out according to the duct manufacturer's installation procedures.

b) Rigid ducts shall be installed parallel to the structural surfaces, either horizontally or vertically, using offset bends or fittings where changes in alignment are necessary.

For surface mounted duct systems, when runs are 50 m or less horizontally:

a) Conduit fittings and junction boxes shall be installed in neat straight lines in the locations specified in the Contract Documents

b) Rigid conduits shall be installed parallel to the structural surfaces, either horizontally or vertically, using offset bends or fittings where changes in alignment are necessary.

Appropriate fittings and deflection couplings shall be used for the installation. PVC boxes shall be mounted to provide the least interference with at least two stainless steel bolts and expansion anchors. Duct connection shall be cemented to the PVC box adapters.

Conduits shall be secured at intervals using conduit straps according to the Ontario Electrical Safety Code.

Conduit straps and junction boxes shall be fastened to concrete surfaces by drilling and inserting concrete anchors and securing the equipment with stainless steel bolts.

Conduit straps and junction boxes shall be fastened to steel structural members using stainless steel hardware.

603.07.11 Utility Clearance

When Utilities interfere with the specified elevation of any ducts, the Contractor shall notify the Contract Administrator to arrange inspection of the crossing point. The Contractor shall adjust the location of the ducts to obtain the clearance required and shall construct any concrete saddle or alternative protection approved by the Utility company.

603.07.12 Breaking Into Concrete Structures

When specified in the Contract Documents, the Contractor shall break into existing electrical chambers and existing substation or controller pads for installing ducts.

The space between the duct and the opening shall be filled with mortar.

603.07.13 Extension of Existing Duct Bank

Extension of existing duct banks shall be as specified in the Contract Documents.

603.07.14 Cable and Duct Protection and Marking

The Contractor shall install cable bricks or concrete protection at locations specified in the Contract Documents. Marker tape shall be installed along the centreline of the trench according the Electrical Safety Code.

Cable brick shall be seated on uniformly graded and compacted material and butted end to end. Multiple rows of bricks shall be installed in trenches with direct buried high-voltage cables and when the width of the trench exceeds 300 mm.

Concrete protection shall be poured on uniformly graded and compacted material occupying the full width of the excavated trench to a minimum depth of 50 mm.

603.07.15 Termination

All ducts shall be temporarily plugged or sealed until wiring is installed. All ducts with wiring installed that terminate in traffic signal control cabinets, Advanced Traffic Management Systems (ATMS) control cabinets, or distribution assemblies shall be sealed.

When ducts are specified in the Contract Documents as spare or intended for future use, the duct ends shall be plugged with plastic plugs.

603.07.16 Backfilling

Except when unshrinkable backfill is used, backfilling shall be according to OPSS 401. Backfill material containing rock fragments and stone larger than 50 mm in diameter shall not be placed within 300 mm of the duct.

Sand bedding shall be placed in trenches for flexible duct when the trench bottom contains sharp rock fragments and when crossover of flexible ducts is required.

Backfill for concrete encased rigid ducts shall be placed at least 24 hours after pouring concrete.

Unshrinkable or granular backfill in trench for rigid ducts crossing paved areas shall extend to the wall of maintenance hole when maintenance holes are required; otherwise, 1.0 m beyond the back face of curb or, when there is no curb, to the back edge of shoulder.

603.07.17 End Marking

The location of the ends of all ducts not terminating in electrical chambers or pole foundations shall be marked by a concrete marker that is flush with the finished grade and located 300 mm beyond the shoulder edge or by a 50 x 50 mm cut cross on curbs, sidewalks, or barriers. The marker shall have an impressed arrow indicating the position of the ducts.

Concrete 400 x 300 x 50 mm markers shall be installed over runs of ducts for communication cables deviating from a straight line. A marker shall be installed wherever a tangent section meets a circular section. When the circular section is more than 20 m in length, an intermediate marker shall be installed.

Concrete markers shall be installed within 72 hours of backfilling of the trench.

603.07.18 Fish Line and Trace Wire

Fish line and trace wire shall be installed in all ducts specified in the Contract Documents as being spare or intended for future use. A 1.5 m length of fish line and trace wire shall extend out of each end of the duct beside the plastic plug, remain coiled, and tied in an accessible location.

603.07.19 Quality Control

603.07.19.01 Pre-Installation Testing and Inspection

All ducts shall be inspected to ensure that they are as specified in the Contract Documents.

All ducts shall be inspected to ensure they are stamped with the appropriate CSA designation, strength, and type. During installation, all ducts shall be inspected to ensure they are properly bedded, have sufficient depth of cover, and are coupled or connected to electrical chambers, poles, or other devices as specified in the Contract Documents.

603.07.19.02 Proof of Performance Testing and Inspection

All ducts shall be inspected and tested to ensure that they are as specified in the Contract Documents. All ducts shall be tested to ensure that they are free of debris, water, breakage, or distortion.

603.07.20 Temporary Electrical Work

The work for temporary electrical installations shall be the same as for permanent installations of the same type of work, except that the work shall include the removal of the installations when they are no longer required.

603.07.21 Site Restoration

Site restoration shall be according to OPSS 492.

603.07.22 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

603.08 QUALITY ASSURANCE

The Owner may perform field tests required for concrete according to OPSS 1350.

The Owner may perform tests for compaction according to OPSS 501.

603.09 MEASUREMENT FOR PAYMENT

603.09.01 Actual Measurement

603.09.01.01 Flexible Ducts
Rigid Ducts, Concrete Encased
Rigid Ducts, Direct Buried
Rigid Ducts by Subsurface Installation
Rigid Ducts, Steel Encased by Subsurface Installation
Flexible Ducts by Subsurface Installation

Measurement of ducts shall be by length in metres horizontally along the longitudinal axis of the duct or trench; from centre to centre of poles, pole footings, electrical chambers, junction boxes, sign footings, and traffic signal controller cabinet pads; and to the face of bridge structures, retaining walls, and substation pads.

603.09.01.02 Rock Excavation for Electrical Installations

Measurement of rock excavation shall be by volume in cubic metres based on the quantity of rock below the upper limit and within the theoretical lines specified in the Contract Documents. The upper limit is the existing rock surface as measured after removal of overburden, but prior to rock excavation or the lowest elevation of all other excavation specified in the Contract Document, whichever is lower.

The volume of boulders in an excavation shall be based on 3 maximum rectilinear dimensions. When boulders classified as rock are measured for payment, only the amount removed shall be considered for payment. The total volume of rock considered for payment shall not exceed the volume of excavation within the theoretical lines.

603.09.01.03 Surface Mounted Duct Systems

Measurement of surface mounted duct systems shall be by length in metres horizontally along the duct, without deductions for junction boxes, from one point of attachment to other points of attachment.

603.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurements.

603.10 BASIS OF PAYMENT

603.10.01 Flexible Ducts - Item
Rigid Ducts, Concrete Encased - Item
Rigid Ducts, Direct Buried - Item
Rigid Ducts by Subsurface Installation - Item
Rigid Ducts, Steel Encased by Subsurface Installation - Item
Rock Excavation for Electrical Installation - Item
Surface Mounted Duct Systems - Item
Flexible Ducts by Subsurface Installation - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

If the Contractor chooses to substitute flexible ducts with rigid ducts, payment for those rigid ducts shall be at the unit price bid for the tender item Flexible Ducts.

When drilling and blasting are required as a part of the work, progress payment shall be made according to OPSS 206.

The work of providing clearance for required Utility crossing shall be administered as Change in the Work.

603.10.02 Flexible Ducts, Temporary - Item
Rigid Ducts, Concrete Encased, Temporary - Item
Rigid Ducts, Direct Buried, Temporary - Item
Rigid Ducts by Subsurface Installation, Temporary - Item
Rigid Ducts, Steel Encased by Subsurface Installation, Temporary - Item
Surface Mounted Duct Systems, Temporary - Item
Flexible Ducts by Subsurface Installation, Temporary - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Materials to do the work.

Progress payment for temporary installation of the above tender items shall be based on the following percentages of the Contract price:

80% for supply and installation

20% for removal

TABLE 1
Ducts and Fittings

Duct and Fitting Description	Type	Direct Buried	Concrete Encased	Subsurface Installation		Embedded Work	Surface Mounted	Standard
				In Ground	In Liner			
PE	Flexible	X	-	-	-	-	-	CSA B137.1 Series 75
ENT	Flexible	X	X	X	X	X	-	CAN/CSA C22.2 No. 227.1
HDPE	Flexible	X	-	X (Note 1)	-	-	-	UL 651A; ASTM F2160, Schedule 40; and NEMA TC 7 for type EPEC
PVC	Rigid	X	X	X	X	X	X	CSA C22.2 No. 211.2
Polymeric PVC	Rigid	-	X Type DB2	-	-	X Type DB2	-	CSA C22.2 No. 211.1
RTRC	Rigid	X standard or heavy wall (Note 2)	X standard or heavy wall	X standard or heavy wall (Note 2)	X standard or heavy wall	X standard or heavy wall	X standard or heavy wall	CSA C22.2 No. 2515
Galvanized Steel	Rigid	X	-	X	X	-	X	CSA C22.2 No. 45.1

Notes:

1. HDPE duct may be used for subsurface installation for extra low-voltage cables only when ducts are 50 mm diameter or smaller.

2. Heavy wall shall be used when ducts are 100 mm diameter or greater.

Appendix 603-A, April 2021
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following the Contract Documents:

- Duct locations and other installation requirements. (603.07.01)

- Trench widths, depths, and alignment. (603.07.05.01)

- Conduit fitting and junction box locations. (603.07.10)

- Duct break-in locations. (603.07.12)

- Existing duct bank locations requiring extension. (603.07.13)

- Cable brick or concrete protection locations. (603.07.14)

- Ducts as spare or future use. (603.07.15)

The designer should determine if the following is required and, if so, specify it in the Contract Documents:

- Need to break into existing electrical chambers and substation or controller pads. (603.07.12)

The designer should provide details for rigid duct connections at concrete structures.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 2100.050	Cable and Duct Protection and Marking
OPSD 2100.060	Rigid Ducts Encased in Concrete
OPSD 2101.010	Duct Installation in Trenches
OPSD 2101.020	Extension of Existing Rigid Ducts Encased in Concrete
OPSD 2102.010	Underground Rigid Duct Connection at Concrete Structure
OPSD 2103.010	Rigid Duct Termination for High Voltage Cables at Utility Poles
OPSD 2103.020	Duct Installation Profiles
OPSD 2103.030	Duct Installation in Existing Paved Area, Unshrinkable Backfill Method
OPSD 2103.040	Rigid Duct Installation in Existing Paved Area, Granular Backfill Method
OPSD 2103.050	Duct Installation at Utility Crossings
OPSD 2103.060	Augering Pits for Subsurface Installation of Ducts and Encasements
OPSD 2104.010	RE Ducts Surface Mounted on Structures
OPSD 2123.010	Electrical Maintenance Holes, Entry of Direct Buried Ducts
OPSD 2123.020	Electrical Maintenance Holes, Entry of Encased Ducts
OPSD 2123.030	Electrical Handholes, Entry of Direct Buried and Encased Ducts
OPSD 2126.010	Distribution Assembly, Concrete Pad and Ducts, Plan and Section A-A
OPSD 2126.020	Distribution Assembly, Concrete Pad and Ducts, Section B-B

CONSTRUCTION SPECIFICATION FOR INSTALLATION OF CABLE

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604.01 SCOPE

This specification covers the requirements for the installation of high-voltage, low-voltage, and extra low-voltage cables, including cable splicing and terminations.

604.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

604.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

604.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 492	Site Restoration Following Installation of Pipelines, Utilities, and Associated Structures
OPSS 603	Installation of Ducts
OPSS 609	Grounding
OPSS 610	Removal of Electrical Equipment and Material

Ontario Provincial Standard Specifications, Material

OPSS 1004	Aggregates - Miscellaneous
OPSS 2409	Traffic Signal Cable
OPSS 2410	Extra Low Voltage Cable

CSA Standards

C22.2 No. 38-14	Thermoset-Insulated Wires and Cables
C22.2 No. 65-13	Wire Connectors
C22.2 No. 129-10 (R2014)	Neutral-Supported Cable
C22.2 No. 197-M1983 (R2013)	PVC Insulating Tape
C22.2 No. 239-09 (R2014)	Control and Instrumentation Cables
C22.3 No. 1-15	Overhead Systems
C57-16	Electric Power Connectors for Use in Overhead Line Conductors
C83-96 (R2016)	Communication and Power Line Hardware
G12-14	Zinc-Coated Steel Wire Strand

Insulated Cable Engineers Association (ICEA)

S-81-570-2005	600 Volt Rated Cables of Ruggedized Design for Direct Burial Installations as Single Conductors or Assemblies of Single Conductors
S-93-639-2000/NEMA WC 74-2006	5 - 46 kV Shielded Power Cables for Use in the Transmission and Distribution of Electrical Energy
S-94-649-2004	Concentric Neutral Cables Rated 5 - 46 kV
S-95-658-2000/NEMA WC70-2009	Power Cables Rated 2000 V or Less for the Distribution of Electrical Energy
S-96-659-2000/NEMA WC71-1999	Non Shielded Power Cables Rated 2001 - 5000 V
S-97-682-2007	Utility Shielded Power Cables Rated 5 - 46 kV
S-105-692-2011	600 Volt Single Layer Thermoset Insulated Utility Underground Distribution Cables

International Municipal Signal Association (IMSA)

19-2-1997	Paired Polyethylene-Insulated Polyvinyl Chloride-Jacketed Communication Cable with Electrical Shield

Electrical Safety Authority (ESA)

Ontario Electrical Safety Code

Others

Electrical and Utilities Safety Association of Ontario Rule Book

604.05 MATERIALS

604.05.01 General

All cables exposed to direct rays of the sun shall be approved for exposure to direct rays of the sun and shall be marked as such according to the Ontario Electrical Safety Code (e.g., SR and Sunlight Resistant).

604.05.02 High-Voltage Cables

604.05.02.01 General

High-voltage cables shall be as specified in the Contract Documents.

604.05.03 Low-Voltage Cables

604.05.03.01 General

Low-voltage multiconductor cables shall be according to CAN/CSA C22.2 No. 239.

Low-voltage single conductor cables shall be type RWU90 according to CSA C22.2 No. 38.

Low-voltage neutral supported cables with one, two, or three insulated aluminum conductors and ACSR neutral shall be 600 V type NS-90 and shall be according to CSA C22.2 No. 129.

Low-voltage multiconductor traffic signal cable shall be according to OPSS 2409.

604.05.03.02 Conductors

Conductors shall be insulated stranded copper and be according to CAN/CSA C22.2 No. 239.

604.05.04 Extra Low-Voltage Cables

Extra low-voltage cables for use with traffic signal interconnection systems shall be according to IMSA No. 19-2.

Extra low-voltage cables for use with traffic signal actuation devices shall be according to OPSS 2410.

604.05.05 Messenger Cables

Messenger cables shall be stranded galvanized steel according to CAN/CSA G12.

604.05.06 Hardware and Fittings

Hardware and fittings for aerial cable installations shall be according to CAN/CSA C83.

604.05.07 Connectors

Cable connectors shall be according to CSA C22.2 No. 65 and CSA C57.

604.05.08 Electrical Insulating Tape

Electrical insulating tape shall be according to CSA C22.2 No. 197 and rated for 600 V and -10 to 90 °C working temperatures.

604.05.09 High-Voltage Splices and Terminations

High-voltage splices, stress relief termination kits, potheads, and cable terminations shall be suitable for indoor or outdoor application as required; shall suit the size, type, and rating of cable used; and shall be according to the requirements of the power supply authority.

604.05.10 Low-Voltage Splices

Low-voltage splices shall be of the type specified in the Contract Documents.

604.05.11 Sand Bedding

Sand bedding shall consist of sand conforming to the gradation requirements of mortar sand according to OPSS 1004.

604.05.12 Fish Line

Fish line shall be nylon or polypropylene material with minimum test strength of 400 N.

604.05.13 Cable Marking

Minimum markings shall consist of manufacturer's name, size of conductor, voltage rating, temperature rating, and type of insulation.

Coloured coded SR rated cables shall be solid coloured or tri-stripe coloured cable and shall be approved according to the Ontario Electrical Safety Code.

604.07 CONSTRUCTION

604.07.01 General

General requirements for electrical work shall be as specified in the Contract Documents.

604.07.02 Removals

Removal shall be according to OPSS 610.

604.07.03 Excavation, Sand Bedding, Backfill, and Compaction

Earth and rock excavation, sand bedding, backfill, and compaction for the installation of direct buried cables shall be according to OPSS 603.

604.07.04 Cable Protection Bricks

Cable protection bricks for direct buried cables shall be installed according to OPSS 603.

604.07.05 Fish Line

A fish line shall be installed in all ducts or conduits when traffic signal cables are installed. A 1.5 m length of fish line shall remain coiled, tied, and accessible in each pole handhole, electrical maintenance hole, junction box, and controller.

604.07.06 Coils and Slack Cable

When specified in the Contract Documents, coils of cable and slack cable shall remain for future extension by others. Coils shall be neatly taped and remain in a readily accessible location. Cable ends shall be sealed with heat shrink tubing boots.

A minimum 300 mm length of lighting and power cables shall remain at all accessible pulling points, splicing points, or cable termination points. A coil length of low-voltage, traffic signal, and extra low-voltage cables shall remain at all electrical maintenance holes and underground junction boxes so that a minimum of 1.0 m total length of cable may be pulled out above finished grade.

604.07.07 Mechanical Support

High-voltage cables passing through electrical maintenance holes shall be wall-mounted on porcelain saddles with galvanized steel cable racks and installed in locations specified in the Contract Documents.

Low-voltage and extra low-voltage cables passing through electrical maintenance holes shall be wall-mounted on galvanized steel cable racks where unsupported lengths of cable exceed 1.2 m. Bend radii shall be kept greater than the minimum recommended by the cable manufacturer and fastened with mechanical supports, where required. All cable and duct expansion joints shall be accurately formed and mechanically supported as specified in the Contract Documents.

Cable splices shall be supported in a similar manner with racks positioned approximately 150 mm on each side of the splice and mounted between 400 and 600 mm below finished grade.

All cables shall be trained to the maintenance hole walls and supported on cable racks. Sufficient rack arms shall be provided to adequately support the cables. All cables shall be bundled neatly with black outdoor nylon cable ties and each circuit identified with vinyl marking bands.

Nylon or stainless steel mesh cable grips shall be installed to support vertical cable runs when the unsupported cable mass exceeds 25 kg.

604.07.08 Barriers

When specified in the Contract Documents, barriers shall be installed between high-voltage and low-voltage cables, between communication and power cables, and between cables with different disconnecting means. Barriers shall be according to the Ontario Electrical Safety Code.

604.07.09 Low Temperature Handling

Cables shall be warmed to at least 0 °C at point of installation prior to installation. Cable shall not be installed when the ambient temperate is below -25 °C.

604.07.10 Cables in Ducts

Cable shall be pulled through ducts using compatible cable lubricant, mechanical aids, and pulling cables or ropes as required. The pulling tension and sidewall bearing pressure (SWBP) shall not exceed the safe tension recommended by the cable manufacturer.

When intermediate pulling points are required for the installation of cables in flexible duct, the flexible duct shall be cut and spliced according to OPSS 603.

604.07.11 Cables, Direct Buried

Cables shall be installed in sand bedding using the cable spacing and depth specified in the Contract Documents. When it is necessary for cables to cross over other cables, a minimum depth of 100 mm of sand bedding material shall be placed between the cables at the point of crossing. When it is necessary for cables to cross Utilities, a minimum separation of 300 mm shall be maintained, above or below the Utility. Such separation shall be backfilled with sand bedding material and a minimum of three cable protection bricks shall be installed over the cables according to OPSS 603.

Marker tape shall be installed along the centreline of all trenches.

604.07.12 Cables, Aerial

Cables shall be tensioned to obtain the sag, clearance, and tension values specified in the Contract Documents for the particular installation temperature.

When specified in the Contract Documents, cables shall be installed on messenger cables. When lashing of cable to a messenger strand is required, a mechanical lashing machine shall be used to install single wound 1.14 mm diameter stainless steel lashing wires. In lieu of lashing wires, and when specified in the Contract Documents, black outdoor nylon cable ties may be used.

Drip loops and expansion loops shall be formed at each pole or conduit entry and held free of the pole or other cables and connections.

Cables shall be re-tensioned, as necessary, to maintain the required cable clearances.

All work shall be according to CAN/CSA C22.3 No. 1, the Ontario Electrical Safety Code, and the Electrical and Utilities Safety Association of Ontario Rule Book.

604.07.13 Splices and Terminations

Cable splices and terminations shall be made at locations specified in the Contract Documents.

Ends of all insulated cables shall be sealed or capped to prevent the ingress of moisture prior to splicing or termination.

High-voltage cable splices and terminations shall be according to the manufacturer's recommendations for the rating and type of cable used.

Low-voltage cable splices for single-stranded conductors installed in electrical chambers shall be made with compression connectors and protected with waterproof covers. Waterproof splices shall be installed according to the manufacturer's recommendations.

Low-voltage and extra low-voltage cable splices for cable installed aerially or above ground shall be made with compression connectors protected with insulating covers.

Low-voltage and extra low-voltage cable splices shall be made by twisting the conductors together with a minimum 12 mm length overlap and connected by the installation of solderless connectors as specified in the Contract Documents. For inductive loop applications, connections shall be soldered. Above ground soldered splices shall be insulated with insulated boots.

All conductors, insulation, and jackets shall be carefully cleaned prior to installing connections, splices, or terminations. All ground shields, braids, or tapes shall be securely connected to a ground wire according to OPSS 609.

Low-voltage and extra low-voltage splices shall be made only in accessible locations such as electrical maintenance holes, junction boxes, and pole handholes.

Traffic signal conductors terminated in pole handholes shall be twisted together and provided with a watertight spring connector. Stranded conductors shall be connected to the terminal strips using the insulated fork tongue compression connectors. Solid conductors shall be connected directly to the terminal board.

604.07.14 Cable Systems

The work of cable systems shall be as described in the Cables in Ducts; Cables, Direct Buried; Cables, Aerial; and Splices and Terminations subsections.

604.07.15 Quality Control

604.07.15.01 General

The Contract Administrator shall be given 24 hours notice of when tests are to be performed. The Contract Administrator may witness all tests and all splice installations.

Tests shall be performed at 500 V for cable insulation rated at less than 600 V and at 1,000 V for cable installation rated 600 V or greater.

604.07.15.02 Pre-Installation Testing and Inspection

Cables, splicing, and connection components shall be inspected prior to installation to ensure that they meet the requirements of the Contract Documents.

604.07.15.03 Proof of Performance Testing and Inspection

The Contractor shall ensure that all cables are installed, tested, and spliced as specified in the Contract Documents and that all cables are energized and in working order.

The test results shall be submitted to the Contract Administrator.

604.07.15.04 High-Voltage Systems

All high-voltage cable systems shall be checked upon completion of the installation of cables, splices, and terminations and prior to connection to switch gear or the source of energy. High potential tests shall be performed on all cables according to Table 1.

604.07.15.05 Low-Voltage Systems

Tests shall be limited to approximately 10% of the total cable system and shall be completed at random locations selected by the Contract Administrator. In the event of failure of any test, the Contract Administrator may choose another 10% of the system for further testing.

The following tests shall be performed prior to energizing the system:

a) The continuity of selected cables shall be checked by means of an ohmmeter test.

   Accumulated resistance shall not exceed the nominal resistance of the cable length, as specified by the cable manufacturer, plus an allowable resistance of 20% per splice or connection.

b) Resistance to ground tests.

   Leakage to ground of selected cables shall be checked by means of a megger test. Resistance to ground shall be 10 megohm or greater.

604.07.15.06 Extra Low-Voltage Systems

Continuity of all cables and connections shall be checked by means of an ohmmeter test prior to energizing the system. This test shall be completed with temporary jumpers installed to by-pass any active system elements or any passive DC blocking devices.

Cables shall be tested for leakage to ground by means of a megger test. Resistance to ground shall be 10 megohm or greater.

604.07.16 Temporary Electrical Work

The work for temporary electrical installations shall be the same as for permanent installations of the same type of work, except that the work shall include the removal of the installations when they are no longer required.

604.07.17 Site Restoration

Site restoration shall be according to OPSS 492.

604.07.18 Management of Excess Material

Management of excess material shall be as specified in the Contract Documents.

604.09 MEASUREMENT FOR PAYMENT

604.09.01 Actual Measurement

604.09.01.01 Cable

Measurement for cable shall be by length in metres horizontally along the longitudinal axis of the duct, trench, or aerial cable; from centre to centre of poles, pole footings, electrical chambers, junction boxes, sign footings, and traffic signal controller cabinet pads; and to the face of bridge structures, retaining walls, and substation pads.

604.09.01.02 High-Voltage Terminations and Splices

For measurement purposes, a count shall be made of the number of high-voltage splices and terminations completed, regardless of the type, size, or rating.

604.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

604.10 BASIS OF PAYMENT

604.10.01

High-Voltage Cables, Direct Buried - Item
Low-Voltage Cables, Direct Buried - Item
Extra Low-Voltage Cables, Direct Buried - Item
Traffic Signal Cables, Direct Buried - Item
Co-Axial Cables, Direct Buried - Item
High-Voltage Cables, in Ducts - Item
Low-Voltage Cables, in Ducts - Item
Extra Low-Voltage Cables, in Ducts - Item
Traffic Signal Cables, in Ducts - Item
Co-Axial Cables, in Ducts - Item
Communication Cables, in Ducts - Item
Low-Voltage Cables, Aerial - Item
Low-Voltage Cables, Aerial with ACSR Neutral - Item
Low-Voltage Cables, Aerial on Messenger Cable - Item
Extra Low-Voltage Cables, Aerial - Item
Extra Low-Voltage Cables, Aerial on Messenger Cable - Item
Traffic Signal Cables, Aerial - Item
Traffic Signal Cables, Aerial on Messenger Cable - Item
Co-Axial Cables, Aerial - Item
Co-Axial Cables, Aerial on Messenger Cable - Item
Communication Cables, Aerial - Item
Steel Messenger Cables, Aerial - Item
ACSR Cables, Aerial - Item
Cable Systems - Item
High-Voltage Terminations and Splices - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

604.10.02 **High-Voltage Cables, Direct Buried (Temporary) - Item**
Low-Voltage Cables, Direct Buried (Temporary) - Item
Extra Low-Voltage Cables, Direct Buried (Temporary) - Item
Traffic Signal Cables, Direct Buried (Temporary) - Item
Co-Axial Cables, Direct Buried (Temporary) - Item
High-Voltage Cables, in Ducts (Temporary) - Item
Low-Voltage Cables, in Ducts (Temporary) - Item
Extra Low-Voltage Cables, in Ducts (Temporary) - Item
Traffic Signal Cables, in Ducts (Temporary) - Item
Co-Axial Cables, in Ducts (Temporary) - Item
Communication Cables, in Ducts (Temporary) - Item
Low-Voltage Cables, Aerial (Temporary) - Item
Low-Voltage Cables, Aerial with ACSR Neutral (Temporary) - Item
Low-Voltage Cables, Aerial on Messenger Cable (Temporary) - Item
Extra Low-Voltage Cables, Aerial (Temporary) - Item
Extra Low-Voltage Cables, Aerial on Messenger Cable (Temporary) - Item
Traffic Signal Cables, Aerial (Temporary) - Item
Traffic Signal Cables, Aerial on Messenger Cable (Temporary) - Item
Co-Axial Cables, Aerial (Temporary) - Item
Co-Axial Cables, Aerial on Messenger Cable (Temporary) - Item
Communication Cables, Aerial (Temporary) - Item
Steel Messenger Cables, Aerial (Temporary) - Item
ACSR Cables, Aerial (Temporary) - Item
High-Voltage Terminations and Splices (Temporary) - Item
Cable Systems (Temporary) - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Progress payment for temporary installation of the above tender items shall be based on the following percentages of the Contract price:

80% for supply and installation

20% for removal

604.10.03 **Rock Excavation**

Payment for rock excavation shall be according to OPSS 603.

TABLE 1
High-Voltage System Testing Requirements

Voltage Rating V	Cable Type	Test Specification
0 - 2,000	Nonshielded	ICEA S-95-658/NEMA WC70
2,001 - 5,000	Nonshielded	ICEA S-96-659/NEMA WC71
5,000 - 46,000	Shielded	ICEA S-93-639/NEMA WC74
5,000 - 46,000	Concentric Neutral	ICEA S-94-649
5,000 - 46,000	Utility Shielded	ICEA S-97-682
600	Single Layer Thermoset Insulated Utility Underground Distribution	ICEA S-105-692
600	Ruggedized Insulated Direct Burial	ICEA S-81-570

Notes:

A. The AC high-voltage test shall be according to ICEA publications, except that the applied test voltage and duration of the test shall be as specified by the power supply authority.

B. The DC high-voltage test shall be according to ICEA publications, except that the applied test voltage and duration of the test shall be as specified by the power supply authority and the cumulative testing time shall not exceed the time limit specified by the power supply authority. If re-testing is required, approval and re-test voltage value shall be obtained from the power supply authority.

Appendix 604-A, November 2017
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- High-voltage cable material requirements. (604.05.02.01)

- Type of low-voltage splices. (604.05.10)

- Location of porcelain saddles and galvanized steel cable racks. (604.07.07)

- Cable and duct expansion joints formed and mechanically supported. (604.07.07)

- Cable spacing and depth. (604.07.11)

- Cable sag, clearance, and tension values. (604.07.12)

- Cable splice and termination locations. (604.07.13)

- Solder or threaded seized-conductor connector. (604.07.13)

- Above ground soldered splices: insulated tubing or insulated boots. (604.07.13)

- Underground soldered splices insulation: waterproof heat shrink tubing or heat shrink boots. (604.07.13)

The designer should determine if the following are required and, if so, they should be specified in the Contract Documents:

- Coils of cable and slack cable. (604.07.06)

- Barriers. (604.07.08)

- Messenger cables. (604.07.12)

- Option of using black outdoor nylon cable ties. (604.07.12)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Appendix 604-A

Related Ontario Provincial Standard Drawings

OPSD 2100.010	Cable Installation in Trenches
OPSD 2100.050	Cable and Duct Protection and Marking
OPSD 2242.010	Wooden Pole with Neutral Supported Cable
OPSD 2242.020	Wooden Pole with Aerial Signal Cable Lashed on Messenger
OPSD 2245.010	Installation of Aerial Cable Systems
OPSD 2245.020	Minimum Vertical Clearances for Aerial Cable Systems
OPSD 2530.010	Splices for Traffic Signal Cable and Extra Low Voltage Cable
OPSD 2545.010	PVC Junction Box for Signal Cable Splicing

CONSTRUCTION SPECIFICATION FOR GROUNDING

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609.10 **BASIS OF PAYMENT**

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609-A **Commentary**

609.01 SCOPE

This specification covers the requirements for the installation of electrical grounding equipment and grounding systems.

609.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

609.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

609.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 492	Site Restoration Following Installation of Pipelines, Utilities, and Associated Structures
OPSS 501	Compacting
OPSS 603	Installation of Ducts
OPSS 610	Removal of Electrical Equipment and Materials

Ontario Provincial Standard Specifications, Material

OPSS 1004	Aggregates - Miscellaneous

CSA Standards

C22.2 No. 38-18	Thermoset-Insulated Wires and Cables
C22.2 No. 41-13 (R2017)	Grounding and Bonding Equipment
G40.20/G40.21-13 (R2018)	General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel
G164-18	Hot Dip Galvanizing of Irregularly Shaped Articles

ASTM International

B 3-13 (2018)	Soft or Annealed Copper Wire

Electrical Safety Authority (ESA)

Ontario Electrical Safety Code

Underwriters Laboratories (UL)

UL 467-March 22, 2013 Grounding and Bonding Equipment

Others

IEEE 837-2002 Standard for Qualifying Permanent Connections Used in Substation Grounding

609.05 MATERIALS

609.05.01 Ground Rods

Ground rods shall be solid steel, 19 mm diameter, 3 m long, copper clad for the full length and shall be according to CSA C22.2 No 41.

609.05.02 Ground Plates

Ground plates shall be hot dip galvanized solid steel, 600 x 600 x 10 mm minimum dimensions. Steel shall be according to CAN/CSA G40.20/G40.21, Grade 260W, and shall be galvanized according to CAN/CSA G164.

609.05.03 Bare Ground Wire

Bare ground wire shall be soft drawn stranded copper and shall be according to ASTM B 3.

609.05.04 Insulated Ground Wire

Insulated ground wire shall be stranded copper, insulation colour green and shall be according to CSA C22.2 No. 38, type RWU 90 - cross-link.

609.05.05 Ground Connectors

Moulded connectors shall consist of metallic alloys and fusible powder mixtures held in place by suitable moulds and connected using an exothermic type welding process. Physical requirements of the connection shall be according to CSA C22.2 No. 41.

Mechanical connectors shall be according to CSA C22.2 No. 41 or UL 467.

High pressure irreversible compression connectors shall be:

a) Made of pure wrought copper extrusion.

b) Made of the same material as the conductors.

c) According to CSA 22.2 No. 41, UL 467, and IEEE 837.

d) Connected according to the manufacturer’s recommendations.

e) Connected using a minimum compressive force of 100 kN and a minimum compressive pressure of 70 MPa.

High pressure irreversible compression connectors shall have crimp verification for the inspection and verification of CSA and UL compliance markings.

609.05.06 Solder

Solder shall be 60/40, tin/lead mix, resin core type.

609.05.07 Sand Bedding

Sand bedding shall consist of sand conforming to the gradation requirements of mortar sand according to OPSS 1004.

609.05.08 Ducts and Fittings

Ducts and fittings shall be CSA approved and as specified in the Contract Documents.

609.07 CONSTRUCTION

609.07.01 General

General requirements for electrical work shall be as specified in the Contract Documents.

All metallic components shall be connected to system ground.

All compaction shall be according to OPSS 501.

609.07.02 Removals

Removals shall be according to OPSS 610.

609.07.03 Excavation and Backfill

Earth and rock excavation and backfill shall be according to OPSS 603.

609.07.04 Ground Wire in Ducts

Ground wire shall be pulled through ducts using cable lubricant, mechanical aids, and pulling cables or ropes as required. The pulling tension shall be according to the cable manufacturer's specifications.

609.07.05 Ground Wire, Direct Buried

When ground wire crosses over direct buried cables, a minimum depth of 100 mm of sand bedding material shall be placed between the ground wire and the buried cables at the point of crossing.

When ground wire does not share a common trench with ducts or direct buried cable, the ground wire shall be installed at a minimum depth of 600 mm below finished grade.

609.07.06 Ground Wire on Poles or Open Surfaces

Ground wire installed on concrete or metal poles shall be run in rigid duct. Ground wire installed on wooden poles shall be run in protective moulding or in rigid duct. In both cases, the conduit or moulding shall be aligned in straight runs complementing the taper of the pole.

The conduit or moulding shall be mechanically fastened to wooden poles using galvanized steel staples. Stainless steel strapping shall be installed to secure conduit on concrete or metal poles.

When ground wire is to be installed on a concrete surface, the concrete shall be drilled to accommodate expandable metal anchors for nylon cable clamps held in place with stainless steel bolts. For installation on wooden surfaces, galvanized steel staples shall be installed. For installation on metal surfaces, nylon cable clamps and stainless steel screws or bolts, nuts, and washers shall be installed. The ground wire shall be installed in straight, neat lines and shall be supported at maximum intervals of 450 mm.

609.07.07 Ground Wire in Electrical Chambers or Enclosures

Ground wires in electrical chambers and enclosures shall be trained towards the structure walls with bend radii greater than the minimum recommended by the cable manufacturer. Ground wires shall be fastened with mechanical supports when required.

Ground wire in electrical chambers shall be connected to ground lugs attached to the frame. For electrical chambers with metallic covers and non-metallic frames, the ground wire shall be connected to the ground lugs attached to the cover. Ground wire in electrical enclosures shall be connected to the ground lug provided.

609.07.08 Ground Wire Connections

Ground connectors shall be used on all ground wire connections. All surfaces shall be cleaned to bare metal prior to making ground connections.

Moulded connectors or high pressure irreversible compression connectors shall be used at pad mounted electrical-electronic equipment, power supply locations, and all locations where the ground connectors are direct buried or inaccessible.

Messenger cables shall be grounded using compression connectors.

609.07.09 Coils of Ground Wire

Coiled ground wire shall be left at the locations shown in the Contract Documents. Coils shall be neatly taped and left in a safe readily accessible location.

609.07.10 Ground Electrodes

609.07.10.01 General

The installation of ground electrodes shall be according to the Ontario Electrical Safety Code.

The work for ground electrodes shall include the work to install ground rods, ground plates, and the associated work described in this specification.

When bedrock, rock fill, or similar materials unsuitable for driving ground rods are encountered at depths of 450 mm to 2.0 m below finished grade, the ground rod shall be replaced with a ground plate.

When bedrock, rock fill, or similar materials are encountered at less than 450 mm below finished grade, the ground electrode shall be installed at a different location when driving of a ground rod or installation of a ground plate is possible.

609.07.10.02 Ground Rods

Ground rods shall be driven in a vertical position when soil conditions allow. When rocks, stones, or similar materials are encountered, ground rods may be driven at a maximum angle of 45° to the vertical.

609.07.10.03 Ground Plates

Ground plates shall be installed on a minimum 150 mm thick compacted bed of suitable native earth material over rock.

609.07.11 Bonding Jumpers

The work for bonding jumpers shall include the work described for ground wire on poles or open surfaces, and ground wire connections.

609.07.12 Grounding Systems

The work included shall be as described for ground wires, ground electrodes, and bonding jumpers.

609.07.13 Quality Control

609.07.13.01 Pre-Installation Testing and Inspection

Grounding cables, bonding jumpers, ground electrodes, and connection components are to be inspected prior to and during installation to ensure that they meet the requirements of the Contract Documents.

609.07.13.02 Proof of Performance Testing and Inspection

All system and components grounding shall be inspected and tested to ensure that they meet the requirements of the Contract Documents. All electrical grounding connections and splices shall be inspected to ensure they have been properly installed.

At pad and pole mounted power supply locations, the resistance to ground of the grounding grid shall be tested and measured. In soils of low conductivity, additional ground rods, ground plates, and ground wires shall be added as required by the Contract Administrator or the Electrical Safety Authority. The Contract Administrator shall be notified 48 hours prior to resistance to ground measurements being taken. These measurements shall be undertaken with the Contract Administrator present under dry soil conditions, and when frost penetration has not exceeded 150 mm. Readings shall not exceed 25 ohms. The test results shall be documented by the Contractor and a copy of the test results shall be given to the Contract Administrator.

609.07.14 Temporary Electrical Work

The work for temporary electrical installations shall be the same as for permanent installations of the same type of work, except the work shall include the removal of the installations when they are no longer required.

609.07.15 Restoration

Site restoration shall be according to OPSS 492.

609.07.16 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

609.09 MEASUREMENT FOR PAYMENT

609.09.01 Actual Measurement

609.09.01.01 Ground Wires

Measurement for ground wire shall be by length in metres horizontally along the longitudinal axis of the duct or trench, or open surface, from centre to centre of poles, pole footings, electrical chambers, or enclosures; sign footings; controller cabinet pads, and ground electrodes; or the face of bridge structures, retaining walls, and substation pads.

609.09.01.02 Ground Electrodes

For measurement purposes, a count shall be made of the number of ground electrodes installed.

609.09.01.03 Bonding Jumpers

For measurement purposes, a count shall be made of the number of bonding jumpers installed.

609.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

609.10 BASIS OF PAYMENT

609.10.01 Ground Wires - Item
Ground Electrodes - Item
Bonding Jumpers - Item
Grounding Systems - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

When the Contract contains separate items for the work required by this specification, payment shall be at the Contract prices and according to the specifications for such work.

609.10.02 Ground Wires (Temporary) - Item
Ground Electrodes (Temporary) - Item
Bonding Jumpers (Temporary) - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Progress payment for temporary installation of the above tender items shall be based on the following percentages of the Contract price:

80% for supply and installation
20% for removal

609.10.03 Rock Excavation for Electrical Installation

Payment for rock excavation for electrical installation shall be according to OPSS 603.

Appendix 609-A, November 2019
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Duct and fitting requirements. (609.05.08)

- Coiled ground wire locations. (609.07.09)

Grounding should be shown symbolically on the contract drawings.

Quantity sheets should include such information as location by station to station or structure to structure, quantities for each location, size of wire, whether bare or insulated wire is used, number of electrodes and bonding jumpers.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 2117.010	Electrical Maintenance Holes, General Installation Requirements
OPSD 2117.020	Electrical Handholes, General Installation Requirements
OPSD 2126.010	Distribution Assembly, Concrete Pad and Ducts, Plan and Section A-A
OPSD 2126.020	Distribution Assembly, Concrete Pad and Ducts, Section B-B
OPSD 2130.010	Supply Control Cabinet Installation, Overhead Services, Top Entry Metering
OPSD 2130.011	Supply Control Cabinet Installation, Underground Services, Bottom Entry Metering
OPSD 2130.012	Supply Control Cabinet Installation, Overhead Services, Bottom Entry Metering
OPSD 2130.013	Supply Control Cabinet Installation, Underground Services, Top Entry Metering
OPSD 2240.010	Wooden Pole with Elliptical Bracket, Overhead and Underground Circuits
OPSD 2255.010	Pole Wiring Diagram, 120V System
OPSD 2255.020	Pole Wiring Diagram, 120/240V System
OPSD 2255.030	Pole Wiring Diagram, 347/600V System
OPSD 2255.040	Pole Wiring Diagram, Lighting Pole on Bridge Structure
OPSD 2400.030	Distribution Assembly, Wiring Schematic
OPSD 2440.010	Supply Control Cabinet Assembly Type 1, 120/240V, 100A, 1-Phase, 3-Wire
OPSD 2440.020	Supply Control Cabinet Assembly Type 2, 120/208V, 100A, 3-Phase, 4-Wire
OPSD 2440.021	Supple Control Cabinet Assembly Type 2, 600/347V, 100A, 3-Phase, 4-Wire
OPSD 2441.000	Supply Control Cabinet Assembly Type 3, 120/240V, 100A, 1-Phase, 3-Wire
OPSD 2453.170	High Mast Lighting Pole, Internal Drive Wiring Diagram, 374/600V, 3-Phase
OPSD 2453.180	High Mast Lighting Pole, Internal Drive Wiring Diagram, 120/240V, 1-Phase
OPSD 2453.210	High Mast Lighting Pole, External Drive Raising and Lowering Equipment, 374/600V, 3-Phase, Wiring Diagram
OPSD 2453.220	High Mast Lighting Pole, External Drive Raising and Lowering Equipment, 120/240V, 1-Phase, Wiring Diagram
OPSD 2528.010	Traffic Signal Equipment, Pole Wiring Diagram
OPSD 2536.010	Flasher Beacons for Roadway Sign and Downlight and Wiring Diagram
OPSD 2540.010	Aerial Traffic Signal Installation
OPSD 2540.020	Aerial Flasher Beacon Installation

OPSD 2547.010	Traffic Signal and Illumination Grounding System
OPSD 2552.010	Traffic Signal System Equipment on Wooden or Concrete Poles, Overhead Wiring Installation
OPSD 2554.010	Traffic Signal System Equipment on Wooden or Concrete Poles, Underground Wiring Installation

ONTARIO PROVINCIAL STANDARD SPECIFICATION

METRIC
OPSS.MUNI 610
APRIL 2017
(formerly OPSS 610, Nov 2008 Reissued Nov 2010)

Note: The MUNI implemented in April 2017 replaces OPSS 610 COMMON, November 2008 reissued in Nov 2010 with no technical content changes.

CONSTRUCTION SPECIFICATION FOR REMOVAL OF ELECTRICAL EQUIPMENT AND MATERIALS

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610.09 **MEASUREMENT FOR PAYMENT - Not Used**

610.10 **BASIS OF PAYMENT**

APPENDICES

610-A **Commentary**

610.01 SCOPE

This specification covers the requirements for demolition, salvage, and removal, either completely or partially, of electrical equipment and materials.

610.01.01 Specification Significance and Use

This specification has been developed for use in municipal-oriented Contracts. The administration, testing, and payment policies, procedures, and practices reflected in this specification correspond to those used by many municipalities.

Use of this specification or any other specification shall be according to the Contract Documents.

610.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

610.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 492 Site Restoration Following Installation of Pipes, Utilities, and Associated Structures
OPSS 510 Removal

610.04 DESIGN AND SUBMISSION REQUIREMENTS

610.04.01 Submission Requirements

610.04.01.01 Operations Plans

An operations plan shall be submitted to the Contract Administrator a minimum of 3 weeks prior to the commencement of polychlorinated biphenyl (PCB) related activities. The plan shall describe the overall approach to the work and include the following:

a) Operational methodologies.

b) Work area delineation and security details.

c) Environmental impact management, such as spill prevention and containment and emergency response plan.

d) Contamination control.

e) Equipment and area decontamination procedures.

f) Ontario Ministry of the Environment (MOE) Environment Compliance Approval numbers as applicable for transportation and transfer facilities.

PCB wastes and PCB related wastes to be moved to a transfer facility shall be included in the operations plan with details regarding their eventual transport to a disposal facility for destruction.

610.07 CONSTRUCTION

610.07.01 General

General requirements for electrical work shall be as specified in the Contract Documents.

Demolition, salvage, and removal of electrical equipment and materials shall be as specified in the Contract Documents.

The Contractor shall acquire all permits, approvals, releases, and agreements necessary to do the work.

610.07.02 Timing of Work

Existing electrical systems required to continue in-service shall remain functional during construction operations until new or modified systems are operational.

610.07.03 Removal

Removal of non-electrical material and objects required for the removal of electrical equipment and material shall be according to OPSS 510.

Electrical concrete structures shall be removed to a minimum of 1.0 m below finished grade.

Where partial removal of pavement, sidewalk, curb and gutter, or other structures is required for removal of electrical equipment, the broken edges of the object to remain in place shall be squared up and trimmed along straight lines at a minimum distance of 300 mm from any area disturbed by removal operations.

Steel reinforcement, conduits, ducts, wires, and debris associated with the removed portions of such structures shall be removed for disposal.

610.07.04 Demolition

Demolition of concrete, brick, timber, and masonry structures, including pole footings, equipment pads, concrete poles, and substation buildings shall be carried out in such a manner and with such equipment as not to disturb adjacent pavement, Utilities, other works, or electrical equipment and material to remain in place and with such care as to leave material designated to be salvaged in an undamaged condition.

610.07.05 Luminaires

Prior to removing luminaires, all lamps and glass shall be removed.

610.07.06 Cables and Conduits

Underground cables shall be completely removed and conduit systems shall be cut back to a depth of 600 mm below finished grade and abandoned in place.

610.07.07 Transformers

Transformers containing PCBs, including all internal components, and all PCB related wastes shall be removed and managed as subject waste as specified in the Contract Documents.

Transformers not containing PCBs shall be removed, salvaged, and transported to storage sites specified in the Contract Documents.

610.07.08 Temporary Installations

Equipment and materials supplied by the Contractor for use with temporary installations shall be removed. Equipment and materials supplied by the Owner for use with temporary installations shall be removed and salvaged as specified in the Contract Documents.

610.07.09 Salvage of Equipment

610.07.09.01 Damages

Due care shall be exercised when removing electrical equipment and materials for salvage. Equipment and materials damaged through improper handling or through loss after removal shall be repaired or replaced.

Prior to removal operations, the Contract Administrator shall be notified of any equipment that is broken or deteriorated to the point where salvage is not practical.

610.07.09.02 Packaging of Electrical Equipment and Materials

Electrical equipment and materials that has been removed shall be packed for protection against damage.

All equipment or material in excess of 100 kg shall be securely mounted on wooden pallets suitable for handling by forklift trucks.

610.07.09.03 Shipping of Salvaged Electrical Equipment and Materials

All salvaged equipment and materials shall be loaded, transported, and unloaded at the sites specified in the Contract Documents.

Delivery to any Owner unloading sites shall be made between 09:00 and 15:30, local time. The Contract Administrator shall be notified 3 Business Days in advance of delivery to the Owner’s unloading sites.

610.07.10 Quality Control

610.07.10.01 Pre-Removal Testing and Inspection

Components specified for removal shall be inspected prior to removal. If the components are to be salvaged for reuse within the Contract limits or for storage at the Owner's premises, the Contractor shall make a list of any imperfections of those components and shall submit the list to the Contract Administrator 3 Business Days prior to the commencement of removal.

610.07.10.02 Proof of Performance Testing and Inspection

The removal work shall be inspected to ensure that all electrical removals have been carried out and that all components requiring disposal at approved sites have been completed so that no such materials remain on the Owner's lands.

610.07.11 Site Restoration

Site restoration shall be according to OPSS 492.

610.07.12 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

610.10 BASIS OF PAYMENT

610.10.01 Removal of Electrical Equipment - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Materials to do the work.

Work required to salvage and transport liquid type transformers shall be paid as Extra Work.

Appendix 610-A, November 2016
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The design should specify the following in the Contract Documents:

- Electrical equipment and materials for demolition, salvage, and removal. (610.07.01)

- Subject waste management requirements. (610.07.07)

- Storage sites for transformers without PCBs. (610.07.07)

- Salvage requirements for equipment and material removed from temporary installations. (610.07.08)

- Salvaged equipment and material unloading sites. (610.07.09.03)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

CONSTRUCTION SPECIFICATION FOR INSTALLATION OF UNDERPASS LUMINAIRES

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APPENDICES

611-A **Commentary**

611.01 SCOPE

This specification covers the requirements for the installation, replacement, and relamping of underpass luminaires.

611.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

611.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

611.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, and publications:

Ontario Provincial Standard Specifications, Construction

OPSS 603	Installation of Ducts
OPSS 604	Installation of Cables
OPSS 609	Grounding
OPSS 610	Removal of Electrical Equipment and Materials

Ontario Provincial Standard Specifications, Material

OPSS 2434	High Pressure Sodium Luminaires for Underpass Lighting

CSA Standards

C22.2 No. 49-18	Flexible Cords and Cables
C22.2 No. 65-18	Wire Connectors
C22.2 No. 197-M83 (R2018)	PVC Insulating Tape
C22.2 No. 227.2.1-19	Liquid-Tight Flexible Nonmetallic Conduit
C22.2 No. 248.8-11 (R2020)	Low-Voltage Fuses - Part 8: Class J Fuses
G40.20-13/G40.21-13 (R2018)	General Requirements for Rolled or Welded Structural Quality Steel / Structural Quality Steel
G164-18	Hot Dip Galvanizing of Irregularly Shaped Articles
W59-18	Welded Steel Construction

American National Standards Institute (ANSI)

C78.380-2016	Electric Lamps – High-Intensity Discharge Lamps - Method of Designation

Illuminating Engineering Society of North America (IESNA)

LM-63-19 Standard File Format for the Electronic Transfer of Photometric Data and Related Information
LM-79-19 Optical and Electrical Measurements of Solid State Lighting Products

611.04 DESIGN AND SUBMISSION REQUIREMENTS

611.04.01 Submission Requirements

A photometric test report shall be submitted for each photometric curve used in the luminaires to be installed under the Contract. The testing and test reports for high intensity discharge (HID) luminaires (e.g., high pressure sodium) shall be according to IESNA LM-63. The testing and test reports for LED luminaires shall be according to IESNA LM-79. The testing and test reports shall be completed by an independent laboratory or a National Voluntary Laboratory Accreditation Program (NVLAP) accredited laboratory, which is accredited for testing the type of luminaire to be installed under the Contract (i.e., accredited for IESNA LM-63 for HID luminaires or IESNA LM-79 for LED luminaires). Each test report shall be dated and signed. The test reports shall be submitted to the Contract Administrator prior to the commencement of fabrication.

611.05 MATERIALS

611.05.01 Luminaires

Underpass luminaires shall be according to OPSS 2434.

611.05.02 Lamps

Lamps shall be clear or coated as specified in the Contract Documents and shall meet the requirements of ANSI C78.380.

611.05.03 Low-Voltage Cables

Single conductor low-voltage cables for use in conduit systems shall be according to OPSS 604.

Low-voltage cable for entry to luminaires shall be single conductor stranded copper and shall be according to CAN/CSA C22.2 No. 49, Type GTF.

611.05.04 Wire Connectors

Wire connectors shall be of the insulated spring or compression type and shall be according to CAN/CSA C22.2 No. 65.

611.05.05 Ground Wire

Ground wire shall be Type GTF.

611.05.06 Fuses

Fuses shall be according to CSA C22.2 No. 248.8, 600V, 10 amps rating.

611.05.07 Ducts and Fittings

Non-metallic flexible liquid-tight ducts and connectors shall be according to CAN/CSA C22.2 No. 227.2.1.

611.05.08 Tape

Electrical insulating tape shall be according to CSA C22.2 No. 197 rated for 600 V and -10 to 90 °C working temperature.

611.05.09 Luminaire Mounting Brackets

Luminaire brackets shall be steel according to CSA G40.20/G40.21, Grade 260W, and shall be hot dip galvanized according to CSA G164.

Welding of members shall be carried out according to CSA W59.

611.05.10 Protective Guard

Luminaires shall be supplied with the luminaire manufacturer's protective guard as specified in the Contract Documents.

611.07 CONSTRUCTION

611.07.01 General

General requirements for electrical work shall be as specified in the Contract Documents.

The work for the installation, replacement, or relamping of the luminaires shall include all required hardware and fixtures to ensure operation of the unit.

611.07.01.01 Ordering Luminaires

Luminaires shall be ordered immediately following Contract award.

The Contract Administrator shall be notified of the delivery dates of the luminaires within 72 hours after Contract award.

Communication with both the Owner and the supplier regarding the delivery, schedules, and requirements for the luminaires shall be timely and accurate.

Delivery and off-loading of the luminaires shall be completed in a timely and efficient manner.

611.07.02 Removals

Removals shall be according to OPSS 610.

611.07.03 Surface-Mounted Ducts

Non-metallic, flexible, liquid-tight ducts and connectors shall be used for connecting the underpass luminaires to the closest junction boxes as specified in the Contract Documents.

Surface-mounted ducts shall be installed according to OPSS 603.

611.07.04 Luminaire Mounting Brackets

When specified in the Contract Documents, the luminaries shall be installed on mounting brackets.

Luminaire mounting brackets shall be fastened to concrete surfaces by drilling and inserting metal expansion anchors and securing the bracket with 10 mm diameter stainless steel machine bolts and lock washers.

Luminaire mounting brackets shall be fastened to steel structural members as specified in the Contract Documents, using stainless steel hardware.

The luminaire mounting bracket shall be fastened to the surfaces to allow the level installation of the luminaire.

611.07.05 Wiring

Wiring shall be installed according to OPSS 604. Each luminaire shall be individually protected with a fuse. The fuse shall be located either in the junction box or in the luminaire. All connectors shall be insulated and secured with tape.

Each luminaire shall be wired with Type GTF conductors connected to the ballast leads with insulated spring connectors secured with tape. GTF conductors shall be connected to the underpass lighting circuits in the junction box with insulated spring connectors secured with tape.

611.07.06 Grounding

Underpass luminaires shall be connected to the system ground according to OPSS 609.

611.07.07 Installation of Luminaires

Luminaires shall be protected from conditions where moisture or dirt could damage the ballasts or reflecting surfaces of the optical system.

Luminaires shall be mounted on concrete surfaces as specified in the Contract Documents by drilling and inserting metal expansion anchors and securing the luminaires with 10 mm diameter stainless steel machine bolts, lock washers, and PVC spacers.

Luminaires shall be mounted on the steel structural members as specified in the Contract Documents, using stainless steel hardware.

All underpass luminaires are to be installed level using stainless steel hardware.

The luminaire reflector and refractor shall be thoroughly cleaned prior to installing lamps.

The wire guard and housing hardware shall be securely fastened in place.

611.07.08 Replacing Luminaires

When specified in the Contract Documents, existing luminaires, associated flexible conduit, and wiring shall be removed and new luminaires, associated flexible conduit, fittings, and wiring shall be installed.

When new luminaires are of a different style than the existing luminaires, new concrete anchors or mounting hardware shall be installed.

611.07.09 Relamping

Existing lamps shall be removed, the luminaires thoroughly cleaned, and new lamps installed.

611.07.10 Quality Control

611.07.10.01 Pre-Installation Testing and Inspection

Luminaires, brackets, socket setting, refractor type, and ballast type shall be inspected to ensure they meet the requirements of the Contract Documents.

611.07.10.02 Proof of Performance Testing and Inspection

Luminaires shall be inspected and tested to ensure that they meet the requirements of the Contract Documents. All lamps installed in luminaires shall have undergone a minimum burning-in period of 100 consecutive nighttime hours prior to acceptance of the work by the Contract Administrator. For daytime tunnel illumination systems, the burn-in time is not required to be continuous and shall be achieved during normal daytime hours.

Low-voltage system tests required on the wiring system shall be performed according to OPSS 604.

611.07.11 Temporary Electrical Work

Temporary electrical work shall be the same as that of permanent electrical work, except it shall include removal when no longer required.

611.07.12 Management of Excess Material

Management of excess material shall be as specified in the Contract Documents.

611.09 MEASUREMENT FOR PAYMENT

611.09.01 Actual Measurement

611.09.01.01 Underpass Luminaires

For measurement purposes, a count shall be made of the number of underpass luminaires installed.

611.09.01.02 Replace Underpass Luminaires

For measurement purposes, a count shall be made of the number of underpass luminaires replaced.

611.09.01.03 Relamp Underpass Luminaires

For measurement purposes, a count shall be made of the number of underpass luminaires relamped.

611.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

611.10 BASIS OF PAYMENT

611.10.01 Underpass Luminaires - Item
Replace Underpass Luminaires - Item
Relamp Underpass Luminaires - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

When the Contract contains separate items for the work required by this specification, payment shall be at the Contract prices and according to the specifications for such work.

611.10.02 Underpass Luminaires, Temporary - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

Progress payments for temporary installation of the above tender item shall be based on the following percentages of the Contract price:

80% for supply and installation
20% for removal

Appendix 611-A, November 2021
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Clear or coated lamps. (611.05.02)

- Luminaire protective guards to be supplied. (611.05.10)

- Location of junction boxes. (611.07.03)

- Location of luminaire installations. (611.07.07)

The designer should determine if the following are required and, if so, specify them in the Contract Documents:

- Luminaires mounted on brackets. (611.07.04)

- Luminaire replacement. (611.07.08)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 2305.020	Underpass Luminaires, Wall Mounted Installation
OPSD 2310.010	Underpass Luminaire, Ceiling Mounted Installation with Tee Bracket
OPSD 2310.020	Tee Bracket for Ceiling Mounted Underpass Luminaire
OPSD 2310.030	Wedge Mounting Bracket for Underpass Luminaire
OPSD 2310.040	Support Bracket for Column Mounted Underpass Luminaire
OPSD 2315.010	Underpass Luminaire Wiring Detail

CONSTRUCTION SPECIFICATION FOR INSTALLATION OF POWER SUPPLY EQUIPMENT

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APPENDICES

614-A **Commentary**

614.01 SCOPE

This specification covers the requirements for the installation of distribution assemblies, supply control cabinet assemblies, service supply pedestals, and service boxes.

614.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

614.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

614.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 602 Installation of Electrical Chambers
OPSS 603 Installation of Ducts
OPSS 604 Installation of Cable
OPSS 609 Grounding
OPSS 616 Footings and Pads for Electrical Equipment

Ontario Provincial Standard Specifications, Material

OPSS 2414 Power Supply Equipment
OPSS 2485 Photoelectric Controllers

Electrical Safety Authority (ESA)

Ontario Electrical Safety Code

614.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Service Box means an approved pole mounted assembly consisting of an enclosure designed and constructed so that it can be locked and sealed; contain either service fuses and a service switch or a circuit breaker, and allow the switch or circuit breaker to be manually operated; and includes a metering compartment when specified in the Contract Documents.

Service Supply Pedestal means an approved ground mounted assembly consisting of an enclosure designed and constructed so that it can be locked and sealed; contain either service fuses and a service switch or a circuit breaker, and allow the switch or circuit breaker to be manually operated; and includes a metering compartment when specified in the Contract Documents.

614.04 DESIGN AND SUBMISSION REQUIREMENTS

614.04.01 Design Requirements

614.04.01.01 Service Supply Pedestals and Service Boxes

Service supply pedestals and service boxes shall be installed in the following manner:

a) Traffic signal installations:

   1. Non-metered pedestal on:

      i. A controller pad foundation; or

      ii. An independent foundation;

   2. Metered pedestal on:

      i. A controller pad foundation; or

      ii. An independent foundation;

   3. Non-metered service box mounted on an independent pole; or

   4. Metered service box mounted on an independent pole.

b) Roadway illumination installations:

   1. Non-metered pedestal on an independent foundation; or

   2. Metered pedestal on an independent foundation; or

   3. Non-metered service box mounted on an independent pole; or

   4. Metered service box mounted on an independent pole.

Service supply pedestals and service boxes shall be installed according to the Contract Documents.

614.04.02 Submission Requirements

The following information shall be submitted to the Contract Administrator:

a) Actual breakdown cost of Utility work, such as hook up, transformation, etc.

b) Utility company contact person's name, title, address, and telephone and mobile phone numbers.

The Utility invoice shall be forwarded to the Contract Administrator for payment or reimbursement to the Contractor. Unless otherwise specified, payment shall be made by the Contract Administrator.

Working drawings shall be submitted according to OPSS 2414.

614.05 MATERIALS

614.05.01 Distribution Assemblies

Distribution assemblies shall be according to OPSS 2414 and the Contract Documents.

614.05.02 Supply Control Cabinet Assemblies

Supply control cabinet assemblies shall be according to OPSS 2414 and the Contract Documents.

614.05.03 Service Supply Pedestals

Service supply pedestals shall be according to OPSS 2414 and the Contract Documents.

614.05.04 Service Boxes

Enclosures for service boxes shall be according to OPSS 2414 and the Contract Documents.

614.05.05 Photoelectric Controllers

Photoelectric controllers shall be according to OPSS 2485.

614.05.06 Cables and Cable Connectors

Cables and cable connectors shall be according to OPSS 604.

614.05.07 Grounding Materials

Grounding materials shall be according to OPSS 609.

614.05.08 Conduit and Fittings

Rigid ducts and fittings shall be according to OPSS 603.

614.07 CONSTRUCTION

614.07.01 General

General requirements for electrical work shall be as specified in the Contract Documents.

Electrical chambers shall be according to OPSS 602 and as specified in the Contract Documents.

Concrete pads shall be according to OPSS 616 and as specified in the Contract Documents.

614.07.02 Distribution Assemblies

Equipment enclosures shall be installed squarely and symmetrically on concrete pads.

A neoprene gasket shall be attached squarely and symmetrically on the bottom base H-beam of the enclosure prior to installation. Base H-beam anchor bolts shall be secured in place at locations specified in the Contract Documents.

614.07.03 Supply Control Cabinet Assemblies

Supply control cabinet assemblies shall be mounted securely on poles using stainless steel strapping.

Rigid ducts and fittings shall be installed on wooden poles using two-hole galvanized pipe straps one trade size larger with galvanized lag screws and on metal or concrete poles using stainless steel strapping, at intervals specified in the Ontario Electrical Safety Code. The conduit system shall be installed in straight lengths to follow the taper of the pole. Offset bends, meter hubs, terminal adapters, and fittings shall be used when required to avoid pole attachments and be kept free of kinks or scorch marks.

When specified in the Contract Documents, a meter socket, acceptable to the power supply authority, shall be installed.

614.07.04 Service Supply Pedestals

Service supply pedestals shall be installed according to the Contract Documents.

A neoprene gasket shall be attached squarely and symmetrically on the bottom of the service supply pedestal prior to installation. Base anchor bolts shall be secured in place at locations specified in the Contract Documents.

614.07.05 Service Boxes

Service boxes shall be installed according to the Contract Documents.

Rigid PVC ducts and fittings shall be installed on wooden poles using two-hole galvanized pipe straps one trade size larger with galvanized lag screws and on metal or concrete poles using stainless steel strapping, at intervals specified in the Ontario Electrical Safety Code. The conduit system shall be installed in straight lengths to follow the taper of the pole. Offset bends, meter hubs, terminal adapters, and fittings shall be used when required to avoid pole attachments and be kept free of kinks or scorch marks.

When specified in the Contract Documents, a meter socket, acceptable to the power supply authority, shall be installed.

614.07.06 Cables and Fuses

Cables, terminations, and connections shall be installed according to OPSS 604. Service cables from the point of service connection to the main disconnecting means shall be installed according to the Ontario Electrical Safety Code and the requirements of the power supply authority.

Only high-voltage fuses that have a current rating approved by the power supply authority shall be installed.

614.07.07 Grounding

All grounding work shall be according to OPSS 609.

All equipment mounted on concrete foundations shall be bonded by means of bonding jumpers connected between the equipment ground bus and the exterior ground grid. Lightning arrestors shall have the ground cable connected securely to the equipment ground bus. The neutral bus of the main disconnecting means or the secondary neutral terminal of the transformer shall be grounded.

The system ground wire and the service ground wire shall be connected to the neutral bus.

614.07.08 Photoelectric Controllers

614.07.08.01 General

Photo-conductive cell windows shall be set to face in a northerly direction and away from any nearby light sources.

614.07.08.02 Distribution Assemblies

Photoelectric controllers shall be installed according to the Contract Documents.

614.07.08.03 Supply Control Cabinet Assemblies

Photoelectric controllers shall be installed on poles with twist lock mounting sockets and brackets. Brackets shall be mounted on metal or concrete poles with stainless steel strapping or on wooden poles with galvanized lag screws.

614.07.08.04 Service Supply Pedestals

Photoelectric controllers shall be installed according to the Contract Documents.

614.07.09 Quality Control

614.07.09.01 Pre-Installation Testing and Inspection

Power supply equipment shall be inspected prior to installation to ensure that it meets the requirements of the Contract Documents. A visual inspection of all the power supply equipment shall be performed prior to its delivery. The following components shall be inspected to ensure that they meet the requirements of the Contract Documents:

a) Barriers and raceways

b) Breakers

c) Cabinet materials

d) Conduits and tubings

e) Contactors

f) Disconnect switches

g) Doors and latching mechanisms

h) Enclosure materials

i) Cabinet general appearance

j) Grounding and bonding materials

k) Grounding connections

l) Insulation

m) Labels

n) Lightning arrestors

o) Panelboards

p) Photoelectric controllers

q) Switches

r) Transformers

s) Wires and connectors

614.07.09.02 Proof of Performance Testing and Inspection

The installed power supply equipment shall be inspected and tested. All components listed under the Pre-Installation Testing and Inspection clause shall be inspected. Low voltage system tests shall be performed on wiring of the equipment according to OPSS 604. Grounding of equipment shall be tested according to OPSS 609.

614.07.10 As Constructed Drawings

In the event changes to the accepted Working Drawings are necessary, as constructed drawings bearing the stamp and signature of an Engineer shall be submitted to the Contract Administrator.

614.07.11 Temporary Electrical Work

The work for temporary electrical installations shall be the same as for permanent installations of the same type of work, except the work shall include the removal of the installations when they are no longer required.

614.07.12 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

614.09 MEASUREMENT FOR PAYMENT

614.09.01 Actual Measurement

614.09.01.01 Distribution Assemblies
Supply Control Cabinet Assemblies
Service Supply Pedestals
Service Boxes

For measurement purposes, a count shall be made of the number of assemblies installed.

614.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

614.10 BASIS OF PAYMENT

614.10.01 Distribution Assemblies - Item
Supply Control Cabinet Assemblies - Item
Service Supply Pedestals - Item
Service Boxes - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

614.10.02 Distribution Assemblies, Temporary - Item
Supply Control Cabinet Assemblies, Temporary - Item
Service Supply Pedestals, Temporary - Item
Service Boxes, Temporary - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, Material to do the work.

Progress payment for temporary installation of the above tender items shall be based on the following percentages of the Contract price:

80% for supply and installation
20% for removal

Additional payment shall not be made for the electrical energy and service required to do the work.

Appendix 614-A, November 2019
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Distribution assembly material requirements as follows: (614.05.01)

  Distribution assembly, pad mounted, ___ kVA
  ___ volt, 3-phase, complete with:
  ___ amp Main fused disconnect ___ volt
  ___ amp Main unfused disconnect
  ___ amp Main lighting breaker
  ___ amp Main auxiliary system fused disconnect
  ___ - ___ amp ___ volt Auxiliary system fused disconnect
  ___ - ___ amp Branch breakers (for lighting panelboard)
  ___ - ___ amp Branch breakers (for ___ volt panelboard)
  ___ amp Meter socket (as per local power supply authority standards)
  Meter socket catalogue No. _____

- Supply control cabinet assembly material requirements as follows: (614.05.02)

  Supply control cabinet assembly, type ___, ___ volt
  ___ amp ___ -phase, complete with:
  ___ amp Main circuit breaker
  ___ amp Traffic signal circuit breaker
  ___ amp Circuit breakers
  ___ amp Meter socket (as per local power supply authority standards)
  Meter socket catalogue No. _____

- Service supply pedestal material requirements as follows: (614.05.03)

  Service supply pedestal, ___ volt
  ___ amp ___ -phase, complete with:
  ___ amp Main circuit breaker
  ___ amp Traffic signal circuit breaker
  ___ amp Circuit breakers
  ___ amp Meter socket (as per local power supply authority standards)
  Meter socket catalogue No. _____

- Service box material requirements as follows: (614.05.04)

  Service box, ___ volt
  ___ amp ___ -phase, complete with:
  ___ amp Main circuit breaker
  ___ amp Traffic signal circuit breaker
  ___ amp Circuit breakers
  ___ amp Meter socket (as per local power supply authority standards)
  Meter socket catalogue No. _____

The designer should determine if the following is required and, if so, specify it in the Contract Documents:

- Meter sockets. (614.07.03)
- Meter sockets. (614.07.05)

The designer should coordinate with the power supply authority the payment for electrical energy and service.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 2126.010 to 2126.020	Distribution Assembly
OPSD 2130.010 to 2130.013	Supply Control Cabinet Installation
OPSD 2135.010	Service Supply Pedestal For Traffic Signal And Street Lighting
OPSD 2140.010	Service Box Installation, Overhead Services
OPSD 2200.050	Precast Pedestal Foundation For Metering Or Street Lighting
OPSD 2400.000 to 2400.030	Distribution Assembly
OPSD 2400.100 to 2400.101	Warning Signs
OPSD 2440.010 to 2441.030	Supply Control Cabinet Assembly
OPSD 2443.010	Service Supply Pedestal For Traffic Signal And Street Lighting, Layout And Wiring Schematic, 120/240V, 100A, 1-Phase, 3-Wire

CONSTRUCTION SPECIFICATION FOR INSTALLATION OF POLES

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615-A **Commentary**

615.01 SCOPE

This specification covers the requirements for the installation of poles used for the mounting of lighting equipment, traffic signals and control equipment, low-voltage aerial cables, and extra low-voltage aerial cables.

615.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

615.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

615.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 492	Site Restoration Following Installation of Pipelines, Utilities, and Associated Structures
OPSS 501	Compacting
OPSS 603	Installation of Ducts
OPSS 609	Grounding
OPSS 610	Removal of Electrical Equipment and Materials
OPSS 904	Concrete Structures

Ontario Provincial Standard Specifications, Material

OPSS 1010	Aggregates - Base, Subbase, Select Subgrade, and Backfill Material
OPSS 1350	Concrete - Materials and Production
OPSS 1440	Steel Reinforcement for Concrete
OPSS 2420	Wooden Poles
OPSS 2421	Spun Concrete Poles
OPSS 2422	Heavy Class Steel and Sectional Steel Poles, Base Mounted
OPSS 2423	Steel Poles, Base Mounted
OPSS 2452	Aluminum Poles, Base Mounted
OPSS 2453	Sectional Steel Poles

CSA Standards

C83-22 Communication and Power Line Hardware
G12-14 (R2019) Zinc-Coated Steel Wire Strand

Others

Ontario Electrical Safety Code

615.05 MATERIALS

615.05.01 Concrete

Concrete shall be according to OPSS 1350 with a nominal minimum 28-Day compressive strength of 30 MPa.

615.05.02 Granular Material

Granular materials shall be Granular A or B according to OPSS 1010.

615.05.03 Steel Reinforcement

Steel reinforcement shall be according to OPSS 1440.

615.05.04 Poles

Concrete poles shall be according to OPSS 2421.

Steel poles for base mounting shall be according to OPSS 2423.

Aluminum poles for base mounting shall be according to OPSS 2452.

Sectional steel poles for direct burial or base mounting shall be according to OPSS 2453.

Wooden poles shall be according to OPSS 2420.

Heavy class steel poles and heavy class sectional steel poles shall be according to OPSS 2422. This class is required for poles with mast arms longer than 5.5 m.

615.05.05 Frangible Bases

Frangible bases shall be as specified in the Contract Documents.

615.05.06 Pole Hardware and Accessories

Pole line hardware shall be according to CSA C83.

Steel guy cable shall be according to CSA G12.

Guy anchors shall be of the helical power driven or direct buried expandable type with a minimum diameter of 250 mm and a minimum anchor rod ultimate strength of 50 kN.

615.07 CONSTRUCTION

615.07.01 General

General requirements for electrical work shall be as specified in the Contract Documents.

Concrete, wooden, and metal poles shall be installed at locations specified in the Contract Documents.

All compaction shall be according to OPSS 501.

Grounding of poles shall be according to OPSS 609 and the Contract Documents.

615.07.01.01 Pole Orientation

Concrete and metal poles shall be installed with the handhole location on the pole as specified in the Contract Documents and such that the top wiring aperture is at right angles to the centreline of the road being served.

615.07.01.02 Pole Handling

Poles shall be handled using suitable non-abrasive slings at the pole pick up points as specified by the pole manufacturer.

615.07.01.03 Removals

Removals shall be according to OPSS 610.

615.07.02 Sectional Steel Poles

615.07.02.01 Assembly

Sectional steel poles shall be assembled in order of section number, taper, and diameter. Sections with wiring apertures shall be set with consideration given to the handhole location.

All sections shall be assembled by compression according to the manufacturer's instructions such that each section meets the normal overlap limits marked on the pole or refusal. Seam welds shall be slightly offset during assembly. The finished length of the pole shall be less than or equal to the nominal pole length.

Pole lengths of 5.64 m or more shall be assembled using three self-tapping screws or impact inserted pins. Screws and pins shall be installed in the overlap of all sections below the signal bracket so that they are spaced equally around the pole.

615.07.03 Direct Buried Poles

615.07.03.01 Installation in Earth

Excavation shall be by auger or by other suitable means to obtain a hole large enough to accommodate concrete encasement and backfill. Where the excavation extends beyond the neat limits specified in the Contract Documents, and, where concrete encasement is specified in the Contract Documents, concrete may be placed to the undisturbed earth or the encasement may be formed with the remainder of the backfill made up of native material.

For hydro vac excavation, backfill material shall consist of granular or limestone screening material.

615.07.03.02 Installation in Rock

Where rock is encountered, the method of installation shall be chosen from those specified in the Contract Documents and be based on the depth of rock below finished grade. Each method of installation in rock shall be approved by the Contract Administrator prior to construction.

Rock anchors, bolts for rock mounts, and steel dowel bars shall be installed in drilled holes and grouted in place with non-shrink grout. Poles shall be cut off at the top end to provide the correct top of pole elevation. Wooden poles that have been cut off shall have the ends treated with preservative according to the pole manufacturer's specifications.

Concrete levelling pads, concrete backfill up to the top of the rock grade, and formed concrete encasement shall be placed according to OPSS 904.

Native or imported earth material shall be used as backfill above or around the concrete encasement and compacted.

Rock excavation shall be according to OPSS 603.

615.07.03.03 Pole Alignment

Direct buried poles shall be held plumb by using a suitable temporary support assembly during concrete setting time and during backfilling operations.

615.07.04 Base Mounted Poles

615.07.04.01 Preparation

Anchorage templates shall be removed prior to installation of poles and frangible bases.

All studs, bolts, and nuts shall be cleaned and coated with white lithium-based grease.

615.07.04.02 Installation of Frangible Bases

When frangible bases are specified in the Contract Documents, they shall be installed according to manufacturer's specifications.

615.07.04.03 Installation of Poles

When specified in the Contract Documents, poles shall be installed on frangible bases.

Poles shall be set plumb.

615.07.05 Apertures

Drilled apertures shall be accurately aligned to suit pole attachments or equipment. Wiring apertures in metal poles shall be provided with rubber grommets. Apertures in metal poles shall be deburred, and in galvanized steel poles, be coated with grey zinc-rich paint and allowed to dry before placing rubber grommets in them.

Unused pole apertures shall be plugged with rubber, neoprene, or plastic plugs.

615.07.06 Guy Anchors

Guy anchors and associated hardware shall be installed as specified in the Contract Documents and the Ontario Electrical Safety Code. Anchorage plates shall be installed at the specified guy lead distance and adjusted to remain clear of any existing guy anchors by a minimum distance of 600 mm and then backfilled with native material and compacted.

Guy anchors shall be installed with single or double guy cable sets as specified in the Contract Documents.

All guy cables shall be installed to a snug condition prior to aerial cable stringing and readjusted upon completion to maintain poles in a plumb position.

Guy cables shall be tightened to maintain pole alignment and aerial cable clearances.

615.07.07 Quality Control

615.07.07.01 Pre-Installation Testing and Inspection

Poles shall be inspected for any obvious flaws, prior to installation.

The Contractor shall certify that sectional steel poles are according to the supplier's design and drawing numbers as specified in OPSS 2453. The Contractor's certification shall reference the supplier's drawing numbers.

The Contractor shall certify that heavy class steel and sectional steel poles are according to the supplier's design and drawings as specified in OPSS 2422. The Contractor's certification shall reference the supplier's drawing numbers.

615.07.07.02 Proof of Performance Testing and Inspection

The work of pole installation shall be inspected to ensure that it is according to the Contract Documents. The inspection shall ensure that:

a) Poles and appurtenances have been properly installed.

b) Poles are plumb.

c) Anchorage assemblies and frangible bases are installed correctly.

615.07.08 Temporary Electrical Work

The work for temporary electrical installations shall be the same as for permanent installations of the same type of work, except the work shall include the removal of the installations when they are no longer required.

615.07.09 Site Restoration

Site restoration shall be according to OPSS 492.

615.07.10 Management of Excess Materials

Management of excess material shall be as specified in the Contract Documents.

615.09 MEASUREMENT FOR PAYMENT

615.09.01 Actual Measurement

615.09.01.01 Poles

For measurement purposes, a count shall be made of the number of poles installed regardless of the type and size of the poles, and shall include any frangible bases and guy anchors installed with the poles.

615.09.01.02 Sectional Steel Poles, Direct Buried in Earth

For measurement purposes, a count shall be made of the number of sectional steel poles direct buried in earth.

615.09.01.03 Concrete Poles, Direct Buried in Earth

For measurement purposes, a count shall be made of the number of concrete poles direct buried in earth.

615.09.01.04 Wooden Poles, Direct Buried in Earth

For measurement purposes, a count shall be made of the number of wooden poles direct buried in earth.

615.09.01.05 Sectional Steel Poles, Direct Buried in Rock

For measurement purposes, a count shall be made of the number of sectional steel poles direct buried in rock.

615.09.01.06 Concrete Steel Poles, Direct Buried in Rock

For measurement purposes, a count shall be made of the number of concrete poles direct buried in rock.

615.09.01.07 Wooden Poles, Direct Buried in Rock

For measurement purposes, a count shall be made of the number of wooden poles direct buried in rock.

615.09.01.08 Sectional Steel Poles, Base Mounted

For measurement purposes, a count shall be made of the number of base mounted sectional steel poles installed.

615.09.01.09 Heavy Class Sectional Steel Poles, Base Mounted

For measurement purposes, a count shall be made of the number of base mounted heavy class sectional steel poles installed.

615.09.01.10 Steel Poles, Base Mounted

For measurement purposes, a count shall be made of the number of base mounted steel poles installed.

615.09.01.11 Heavy Class Steel Poles, Base Mounted

For measurement purposes, a count shall be made of the number of base mounted heavy class steel poles installed.

615.09.01.12 Aluminum Poles, Base Mounted

For measurement purposes, a count shall be made of the number of base mounted aluminum poles installed.

615.09.01.13 Frangible Bases

For measurement purposes, a count shall be made of the number of frangible bases installed.

615.09.01.14 Guy Anchors

For measurement purposes, a count shall be made of the number of guy anchors installed, regardless of the size and type.

615.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

615.10 BASIS OF PAYMENT

615.10.01 Poles - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Materials to do the work.

When the Contract contains separate items for the work required by this specification, payment shall be at the Contract price for such work.

615.10.02
Sectional Steel Poles, Direct Buried in Earth - Item
Concrete Poles, Direct Buried in Earth - Item
Wooden Poles, Direct Buried in Earth - Item
Sectional Steel Poles, Direct Buried in Rock - Item
Concrete Poles, Direct Buried in Rock - Item
Wooden Poles, Direct Buried in Rock - Item
Sectional Steel Poles, Base Mounted - Item
Heavy Class Sectional Steel Poles, Base Mounted - Item
Steel Poles, Base Mounted - Item
Heavy Class Steel Poles, Base Mounted - Item
Aluminum Poles, Base Mounted - Item
Frangible Bases - Item
Guy Anchors - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

615.10.03 **Sectional Steel Poles, Direct Buried in Earth (Temporary) - Item**
Concrete Poles, Direct Buried in Earth (Temporary) - Item
Wooden Poles, Direct Buried in Earth (Temporary) - Item
Sectional Steel Poles, Direct Buried in Rock (Temporary) - Item
Concrete Poles, Direct Buried in Rock (Temporary) - Item
Wooden Poles, Direct Buried in Rock (Temporary) - Item
Sectional Steel Poles, Base Mounted (Temporary) - Item
Steel Poles, Base Mounted (Temporary) - Item
Aluminum Poles, Base Mounted (Temporary) - Item
Frangible Bases (Temporary) - Item
Guy Anchors (Temporary) - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Materials to do the work.

Progress payment for the above tender items shall be based on the following percentages of the Contract price:

80% for supply and installation

20% for removal

615.10.04 **Rock Excavation**

Payment for rock excavation shall be according to OPSS 603.

Rock excavation shall not include holes drilled in rock for the placement of steel dowel bars.

Appendix 615-A, November 2022
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Type and location of poles. (615.07.01)

- Excavation beyond the neat limit. (615.07.03.01)

- Concrete encasement for direct buried poles. (615.07.03.01)

- Single or double guy cable sets. (615.07.08)

The design should determine if the following is required and, if so, it should be specified in the Contract Documents:

- Poles installed on frangible base locations. (615.07.04.02)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 2200 Series	Electrical Foundations
OPSD 2410.010	Spun Concrete Pole
OPSD 2410.020	18.3 m Spun Concrete Pole for TV Camera Mounting
OPSD 2414.010	3.3m Aluminum and Sectional Steel Poles, Based Mounted
OPSD 2415.011	Steel Pole, Base Mounted
OPSD 2416.011	Steel Pole, Concrete Barrier Mounted
OPSD 2428.010	Frangible Bases
OPSD 2432.010	Aluminum Pole, Base Mounted

CONSTRUCTION SPECIFICATION FOR FOOTINGS AND PADS FOR ELECTRICAL EQUIPMENT

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616.09 **MEASUREMENT FOR PAYMENT**

616.10 **BASIS OF PAYMENT**

APPENDICES

616-A **Commentary**

616.01 SCOPE

This specification covers the requirements for the installation of footings and pads required for mounting electrical equipment.

616.01.01 Specification Significance and Use

This specification has been developed for use in municipal oriented Contracts. The administration, testing, and payment policies, procedures, and practices reflected in this specification correspond to those used by many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

616.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

616.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 206	Grading
OPSS 492	Site Restoration Following Installation of Pipelines, Utilities, and Associated Structures
OPSS 501	Compacting
OPSS 603	Installation of Ducts
OPSS 610	Removal of Electrical Equipment and Materials
OPSS 904	Concrete Structures
OPSS 905	Steel Reinforcement for Concrete

Ontario Provincial Standard Specifications, Material

OPSS 1004	Aggregates - Miscellaneous
OPSS 1010	Aggregates - Base, Subbase, Select Subgrade, and Backfill Material
OPSS 1301	Cementing Materials
OPSS 1302	Water
OPSS 1308	Joint Filler in Concrete
OPSS 1350	Concrete - Materials and Production
OPSS 1440	Steel Reinforcement for Concrete

CSA Standards

G40.20-13/G40.21-13	General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel
G164-M92 (R2003)	Hot Dip Galvanizing of Irregularly Shaped Articles
W59-13	Welded Steel Construction (Metal Arc Welding)

ASTM International

A 53/A 53M-12	Pipe, Steel, Black and Hot Dipped, Zinc Coated, Welded, and Seamless
A 193/A 193M-17	Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Services and Other Special Purpose Applications
A 563M-15	Carbon and Alloy Steel Nuts

American National Standards Institute (ANSI)

B18.22.1-1965 (R2008) Plain Washers

Society of Automobile Engineers (SAE)

J403 - 2014 Chemical Composition of SAE Carbon Steels

616.05 MATERIALS

616.05.01 Concrete

Concrete shall be according to OPSS 1350 with a nominal minimum 28-Day compressive strength of 30 MPa.

616.05.02 Steel Reinforcement

Steel reinforcement shall be according to OPSS 1440.

616.05.03 Granular Material

Granular materials shall be Granular A or B according to OPSS 1010.

616.05.04 Ducts and Fittings

Ducts and fittings shall be according to OPSS 603.

616.05.05 Anchorage Assemblies and Hardware

All steel components shall be hot dipped galvanized according to CAN/CSA G164.

616.05.05.01 Anchor Assembly Struts

Anchor assembly struts shall be grade SAE 1030 steel according to SAE J403.

616.05.05.02 Studs, Nuts, and Washers

Studs shall be grade SAE C1541 steel according to SAE J403, high tensile stress proof with a yield strength of 690 MPa, and a tensile strength of 860 MPa.

Hex nuts shall be steel grade B steel according to ASTM A 563.

Washers shall be according to ANSI B18.22.1.

616.05.05.03 Ferrules

Steel ferrules shall be grade AISI C12L14 rotoprobed bar according to SAE J403.

616.05.06 Steel Footings and Hardware

Steel footings and hardware shall be grade SAE 1020 steel according to SAE J403.

Steel top plates and steel equipment base plate shall be according to CSA G40.20/G40.21, Grade 260WT minimum.

Steel for footing shafts smaller than 150 mm in diameter shall be according to ASTM A 53.

Steel for footing shafts 150 mm and larger in diameter shall be hollow structural sections according to CSA G40.20/G40.21, Grade 350W minimum.

Welding of the top plate shall be according to CSA W59 minimum.

Steel footings, steel equipment base plate, and mounting hardware shall be hot dip galvanized according to CSA G164.

Stainless steel bolts, nuts, and flat washers shall be according to ASTM A 193.

616.05.07 H-Section Assemblies and Hardware

H-section assemblies and hardware shall be grade SAE 1020 steel according to SAE J403.

Steel plate for H-section and the H-section shall be according to CSA G40.20/G40.21, Grade 260WT minimum.

H-section shall be HP200x54.

All welding shall be according to CSA W59 minimum.

H-section anchorage assemblies and mounting hardware shall be hot dip galvanized according to CAN/CSA G164.

616.05.08 Joint Filler

Expansion joint filler shall be Type A or B according to OPSS 1308.

616.05.09 Grout

Grout shall consist of a mixture of one part Portland cement according to OPSS 1301 and two parts mortar sand according to OPSS 1004, wetted with sufficient water to make the mixture plastic. Water shall be according to OPSS 1302.

616.05.10 Wooden Pads

Wooden pads for controller cabinet shall be as specified in the Contract Documents.

616.06 EQUIPMENT

Equipment for the installation of steel footings shall be according to the following minimum requirements:

a) Boom truck complete with hydraulic take-off.

b) Hydraulically operated torque head with a minimum torque rating of 16,000 N·m complete with Kelly bar drive.

c) Kelly bar adapter and universal driving plate.

d) Torque indicator.

616.07 CONSTRUCTION

616.07.01 General

General requirements for electrical work shall be as specified in the Contract Documents.

616.07.02 Removal

Removals shall be according to OPSS 610.

616.07.03 Concrete Footings and Pads

616.07.03.01 General

616.07.03.01.01 Excavation

Earth excavation for footings shall be carried out by mechanical excavation or by hand digging.

Rock excavation shall be according OPSS 206.

616.07.03.01.02 Steel Reinforcement

Steel reinforcement shall be according to OPSS 905.

616.07.03.01.03 Concrete

Concrete shall be placed, finished, cured, and protected according to OPSS 904. Concrete shall be sampled and tested according to OPSS 1350.

Concrete in earth shall be placed directly against the undisturbed walls of the excavation or may be formed in place, provided that a minimum of 300 mm width is available for placing granular backfill. The upper portion of the footing shall be formed to a minimum of 75 mm below grade level.

When concrete is placed immediately adjacent to other concrete structures or pavement, expansion joint filler shall be installed around the abutting edge of the footing.

Concrete finish for footings installed in concrete barrier wall shall match the barrier wall finish.

616.07.03.01.04 Grading

The Contractor shall excavate and place fill material to the finished grade elevation according to OPSS 206.

616.07.03.02 Concrete Footings

616.07.03.02.01 Sleeves and Ducts

Sleeves for footings shall be accurately located to suit incoming ducts or cable systems and shall be securely tied to the steel reinforcement prior to placing concrete.

All sleeves or ducts shall be cut off cleanly above the footing at the height specified in the Contract Documents.

Sleeves or ducts shall be temporarily plugged or sealed until wiring is installed. Where ducts or sleeves are specified as spare or intended for future use, the ducts or sleeves shall be plugged with plastic plugs.

Location of sleeves or ducts shall be marked on the top of the concrete footing with a 50 x 50 mm cut or formed cross.

616.07.03.02.02 Anchorage Assemblies

Anchorage assemblies shall be installed using studs as specified in the Contract Documents.

Anchorage assemblies of the size and type specified in the Contract Documents shall be accurately positioned in the pole and sign footings. The alignment of the studs shall be parallel to the edge of the driving lane. Anchorage assemblies shall be securely tied to the steel reinforcement.

Studs shall be factory inserted in the ferrules and held in place with a pre-applied thread locking compound. A wooden template shall be provided. Nuts and washers shall be installed hand tight by the fabricator. Studs shall have the exposed threads above the ferrule coated with factory applied white lithium grease. The integrity of the compound shall be maintained throughout the installation and no attempt shall be made to remove or adjust the studs.

The anchorage assembly shall be installed and adjusted level in all directions on the wooden template using a carpenter's level. Upon initial concrete set, the wooden template shall be removed and the drainage channels and other surface features shall be completed.

When the removal of the studs for repair or replacement purposes is required, the ferrules and the studs shall be cleaned to remove the old thread locking compound. New thread locking compound shall be applied to the insertion length of the studs prior to tightening to full depth.

616.07.03.02.03 H-Section Assemblies

H-section for barrier walls shall be accurately positioned in the concrete footings under the concrete barrier. The alignment of the studs shall be parallel to the edge of the driving lane. The plumb position of the anchorage assemblies shall be maintained during the placing of concrete.

616.07.03.02.04 Concrete

Concrete pole footings shall be placed so that the top of the footing is within $\pm$ 25 mm of the elevation specified in the Contract Documents.

616.07.03.02.05 Granular Backfill

When granular backfill is specified in the Contract Documents or, when granular backfill is placed around footings, it shall be compacted according to OPSS 501.

616.07.03.02.06 Concrete Footings in Earth

Concrete footings in earth shall be placed at locations specified in the Contract Documents.

616.07.03.02.07 Concrete Footings in Rock

The work for concrete footings in rock shall include placing dowels and concrete. Concrete footings in rock shall to be placed at locations specified in the Contract Documents.

616.07.03.02.07.01 Dowels in Rock

When specified in the Contract Documents, steel dowel bars shall be installed. Dowel bars shall be grouted in holes drilled into rock using non-shrink grout.

616.07.03.03 Concrete Pads

Concrete pads shall be placed at locations specified in the Contract Documents.

616.07.03.03.01 Granular Bases

Granular material shall be placed as foundation for concrete pads. Granular material shall be placed in conjunction with the installation of ducts under the concrete pads. The granular base shall be compacted according to OPSS 501.

616.07.03.03.02 Sleeves and Ducts

Sleeves and ducts shall be located within the concrete pads as specified in the Contract Documents so that cables may be installed vertically to the cable terminations in the pad mounted equipment.

Ducts shall be installed below pads according to OPSS 603 and shall be suitably aligned for connection to exterior duct or cable systems.

616.07.04 Steel Footings

616.07.04.01 Installation

The Contractor shall install steel footings larger than 150 mm diameter using the equipment as outlined in the Equipment section. Alternate methods of applying torque are permitted for 150 mm diameter or smaller steel footings.

During installation, the steel footing shall be maintained in a plumb position by use of a carpenter's level or a survey instrument. In all cases, the steel footing shall be installed so that the final location of the top plate rests on or is slightly below final grade. Steel footings to be used for poles shall be oriented such that the top plate is either perpendicular to or parallel to the edge of pavement, as required by duct orientation. Steel footings for other equipment mounting shall be oriented to suit the equipment to be mounted.

Steel footings shall be installed by turning the units into the earth at locations specified in the Contract Documents. Torque on footings larger than 150 mm in diameter shall be monitored and recorded during the turning operation and shall show a consistent and gradually increasing torque as the footing advances in depth.

When difficulties are encountered installing the steel footing due to the presence of boulders or rock fragments; or where the torque required to install the footing exceeds 20,000 N·m; or where the torque is less than 5,000 N·m when the shaft is fully driven into the ground, the footing shall be withdrawn and relocated 1.0 m minimum away from the original position, as approved by the Contract Administrator. If turning of the footing proves impractical, a pilot hole of 150 mm diameter may be predrilled and the footings then turned into the pilot hole. If this method proves impractical, a hole of 300 mm maximum diameter may be augured and the footing then installed into the hole. Compacted limestone screenings or expandable foam backfill shall be placed around the shaft to the bottom of the wiring aperture. Backfill of native material shall be placed above this level and compacted according to OPSS 501.

If the steel footings cannot be installed due to local conditions, a concrete footing shall be installed.

616.07.04.02 Mounting Hardware and Steel Equipment Base Plate

The mounting hardware and steel equipment base plate shall be installed as specified in the Contract Documents.

616.07.05 Wooden Pads

616.07.05.01 Installation

Wooden pads for controller cabinets shall be fabricated and placed at locations specified in the Contract Documents.

616.07.05.02 Granular Bases

A granular base shall be installed as a foundation for wooden pads. Granular material shall be placed in conjunction with the installation of ducts under the wooden pads. The granular base shall be compacted according to OPSS 501.

616.07.05.03 Sleeves and Ducts

Sleeves in wooden pads shall be located so that cables may be installed vertically to the cable terminations in the pad mounted equipment. Ducts shall be installed below the pads according to OPSS 603 and shall be suitably aligned for connection to exterior duct or cable systems.

616.07.06 Quality Control

616.07.06.01 Pre-Installation Testing and Inspection

Anchorage assemblies, studs or bolts, and connection components shall be inspected prior to installation to ensure that they are according to the Contract Documents.

616.07.06.02 Proof of Performance Testing and Inspection

The work shall be inspected to ensure that it is according to the Contract Documents. The work shall be inspected to ensure that all components are installed and that all footings and pads, including anchorage assemblies, are properly oriented and in working order.

616.07.07 Temporary Electrical Work

The work for temporary electrical installations shall be the same as for permanent installations of the same type of work, except that the work shall include the removal of the installations when they are no longer required.

616.07.08 Site Restoration

Site restoration shall be according to OPSS 492.

616.07.09 Management of Excess Material

Management of excess material shall be as specified in the Contract Documents.

616.08 QUALITY ASSURANCE

The Owner may perform tests for concrete according to OPSS 1350.

The Owner may perform tests for compaction according to OPSS 501.

The Owner may inspect each pole footing as specified in the Contract Documents.

616.09 MEASUREMENT FOR PAYMENT

616.09.01 Actual Measurement

616.09.01.01 Concrete Footings in Earth

For measurement purposes, a count shall be made of the number of concrete footings installed in earth.

616.09.01.02 Concrete Footings in Rock

For measurement purposes, a count shall be made of the number of concrete footings installed in rock.

616.09.01.03 Concrete Pads

For measurement purposes, a count shall be made of the number of concrete pads installed.

616.09.01.04 Steel Footings

For measurement purposes, a count shall be made of the number of steel footings installed.

616.09.01.05 Wooden Pads

For measurement purposes, a count shall be made of the number of wooden pads installed.

616.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

616.10 BASIS OF PAYMENT

616.10.01 Concrete Footings in Earth - Item
Concrete Footings in Rock - Item
Concrete Pads - Item
Steel Footings - Item
Wooden Pads - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

When a specified steel footing cannot be placed due to local conditions and a concrete footing is installed in its place, such work shall be paid as Extra Work.

616.10.02 **Concrete Footings in Earth, Temporary - Item**
Concrete Footings in Rock, Temporary - Item
Concrete Pads, Temporary - Item
Steel Footings, Temporary - Item
Wooden Pads, Temporary - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Progress payment for the above tender items shall be based on the following percentages of the Contract price:

80% for supply and installation

20% for removal

Appendix 616-A, April 2018
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Wooden pad requirements. (616.05.10)

- Cut-off grade for sleeves and ducts. (616.07.03.02.01)

- Size and type of anchorage assemblies. (616.07.03.02.02)

- Top of concrete pole footing elevation. (616.07.03.02.04)

- Concrete footing in rock locations. (616.07.03.02.07)

- Concrete pad locations. (616.07.03.03)

- Steel footing locations. (616.07.04.01)

- Wooden pad locations. (616.07.05.01)

OPS standards for pole footings do not apply to cohesionless soils. The designer should confirm that the soils are cohesive soils before applying the OPS standards.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 2200.010	Concrete Footing for Base Mounted Lighting and Signal Poles
OPSD 2200.020	Concrete Foundation for Direct Buried Lighting Poles Where Rock is Encountered
OPSD 2200.030	Concrete Foundation for Base Mounted Lighting Poles Where Rock is Encountered
OPSD 2200.040	Concrete Footing and Anchorage Assembly for 3.3 m Base Mounted Metal Pole
OPSD 2200.070	Pole Footing in Earth for Cast-in-Place Concrete Barrier
OPSD 2200.080	Pole Footing in Rock for Cast-in-Place Concrete Barrier
OPSD 2203.030	Steel Equipment Base Plate for Controller Cabinet
OPSD 2210.010	Local Grading at Pole Foundations
OPSD 2210.020	Installation of Direct Buried Poles in Slopes
OPSD 2215.020	Anchorage Assembly
OPSD 2215.030	Pole Mounting Details for Base Mounted Metal Pole
OPSD 2216.010	Anchorage Assembly for Pole Footing in Concrete Barrier
OPSD 2514.020	Concrete Pad for Controller Cabinet

CONSTRUCTION SPECIFICATION FOR INSTALLATION OF ROADWAY LUMINAIRES

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APPENDICES

617-A **Commentary**

617.01 SCOPE

This specification covers the requirements for the installation of luminaires and brackets on poles complete with associated wiring and connections.

617.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

617.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

617.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 604	Installation of Cable
OPSS 609	Grounding
OPSS 610	Removal of Electrical Equipment and Materials

Ontario Provincial Standard Specifications, Material

OPSS 2432	High Pressure Sodium Luminaires for Highway Lighting

CSA Standards

C22.2 No. 9.0-96 (R2016)	General Requirements for Luminaires
C22.2 No. 65-18	Wire Connectors
C22.2 No. 211.2-06 (R2016)	Rigid PVC (Unplasticized) Conduit
C22.2 No. 248.8-11 (R2016)	Low-Voltage Fuses - Part 8: Class J Fuses
C83-17	Communication and Power Line Hardware

American National Standards Institute (ANSI)

C78.380-2016	High-Intensity Discharge Lamps, Method of Designation

Illuminating Engineering Society of North America (IESNA)

LM-63-02	Standard File Format for Electronic Transfer of Photometric Data and Related Information
LM-79-08	Electrical and Photometric Measurements of Solid-State Lighting Products

617.04 DESIGN AND SUBMISSION REQUIREMENTS

617.04.01 Submission Requirements

A photometric test report shall be submitted for each photometric curve used in the luminaires to be installed under the Contract. The testing and test reports for high intensity discharge (HID) luminaires (e.g., high pressure sodium) shall be according to IESNA LM-63. The testing and test reports for LED luminaires shall be according to IESNA LM-79. The testing and test reports shall be completed by an independent laboratory or a National Voluntary Laboratory Accreditation Program (NVLAP) accredited laboratory, which is accredited for testing the type of luminaire to be installed under the Contract (i.e., accredited for IESNA LM-63 for HID luminaires or IESNA LM-79 for LED luminaires). Each test report shall be dated and signed. The test reports shall be submitted to the Contract Administrator prior to the commencement of fabrication.

617.05 MATERIALS

617.05.01 Luminaires

617.05.01.01 Roadway Lighting Type

Roadway lighting luminaires shall be according to OPSS 2432 and the Contract Documents.

617.05.01.02 High Mast Lighting Type

High mast lighting luminaires shall be according to OPSS 2432 and the Contract Documents.

617.05.01.03 Floodlighting Type

Floodlighting luminaires shall be according to CSA C22.2 No. 9.0 and the Contract Documents.

617.05.02 Lamps

Lamps shall be high pressure sodium according to ANSI C78.380 with ANSI lamp designations shown in Table 1. Lamp wattages shall be permanently marked using a label affixed to the underside of the luminaires as specified in the Contract Documents.

617.05.03 Low-Voltage Cables

Single conductor low-voltage cables shall be according to OPSS 604.

617.05.04 Wire Connectors

Wire connectors shall be of the compression type and shall be according to CAN/CSA C22.2 No. 65.

617.05.05 Insulating Covers

Insulating covers for connectors shall be of the vinyl snap lock type or heat shrink tubing type and rated at 600 V.

617.05.06 Brackets

Brackets shall be as specified in the Contract Documents.

617.05.07 Conduit and Fittings

Conduit and fittings required for wooden pole mounting shall be of the rigid PVC type according to CSA C22.2 No. 211.2.

617.05.08 Hardware

Hardware for wooden pole mounting shall be according to CSA C83.

617.05.09 Grounding Materials

Ground wire and connectors shall be according to OPSS 609.

617.05.10 Fuse Holders and Fuses

Fuse holders shall be of the in-line type suitable for use with #12 AWG conductors, rated 600 V, and shall be complete with protective boots. Fuses shall be according to CSA C22.2 No. 248.8, 600 V with a current rating as specified in the Contract Documents.

617.07 CONSTRUCTION

617.07.01 General

General requirements for electrical work shall be as specified in the Contract Documents.

617.07.01.01 Ordering Luminaires

Immediately following the award of the Contract, the Contractor shall order the luminaires as required for this Contract.

The Contractor shall obtain verification of the delivery dates of the luminaires from the supplier and notify the Contract Administrator of the delivery dates within 72 hours after the award of the Contract.

The Contractor shall ensure there is timely and accurate communication with both the Owner and the supplier regarding the delivery, schedules, and requirements for the luminaires.

Delivery and off-loading of the luminaires shall be completed in a timely and efficient manner.

617.07.02 Removals

Removals shall be according to OPSS 610.

617.07.03 Lamp Installation

Lamps shall be installed after poles have been erected and the brackets and luminaires mounted and levelled.

617.07.04 Brackets

617.07.04.01 Roadway Lighting Type

Brackets shall be installed at right angles to the centreline of the roadway being served. Bracket clamping assemblies shall be securely tightened. Brackets shall be mounted on wooden poles using 16 mm diameter galvanized steel square head through bolts, nuts, and 50 x 50 mm washers.

617.07.04.02 Floodlighting Type

Bracket assemblies shall be oriented to give the floodlight aiming specified in the Contract Documents. Bracket clamping assemblies shall be securely tightened.

617.07.05 Luminaires

617.07.05.01 General

Luminaires shall be stored in conditions free of moisture, dirt, and other factors that could damage the ballasts or reflecting surfaces of the optical system.

Luminaires shall be mounted on brackets and shall be installed level along both the longitudinal and transverse axis.

Luminaire clamping assemblies shall be securely tightened upon completion of levelling.

Luminaires shall be orientated and aimed using the horizontal and vertical angles specified in the Contract Documents. When instructed by the Contract Administrator, each luminaire or luminaire component shall be readjusted once under nighttime operating conditions.

Glass refractors shall be installed complete with gaskets. Mounting hardware shall be securely tightened. The luminaire reflector and refractor shall be thoroughly cleaned prior to installing lamps. Lamps shall be installed with the installation date marked on the lamp base.

If required, the refractor and the lamp holder shall be reset or replaced according to manufacturer's instructions to give the proper type of light distribution specified in the Contract Documents.

When specified in the Contract Documents, the luminaires shall be equipped with shields. The shields shall be mounted in such a manner so as to prevent loosening, turning, or falling when subject to vibration or wind loading in the installed position and to permit relamping without removing or distorting the alignment of the shields.

The shield shall be installed according to the manufacturer’s instructions. The orientation of each shield shall be as specified in the Contract Documents. After the shield is attached to the luminaire-retaining ring, it shall be rotated such that its centre (the deepest point) is aligned with the specified angle. The angle specified is based on geometric rotation with the true north as its reference (0 degrees). Once the shield is aligned to the specified angle, it shall be secured in place by tightening the holding ring.

The luminaire assembly when closed and in the operating position shall not be subject to damage by vibration.

617.07.05.02 High Mast Lighting Type

A maximum of one luminaire shall be installed on each arm of the luminaire ring.

Each luminaire shall be bolted and secured onto its respective luminaire arm.

617.07.06 Wiring and Connections

Riser wires in metal and concrete poles shall be terminated at the luminaire terminal block and installed through the bracket and pole to the pole handhole.

Riser wires on wooden poles shall enter the bracket with a drip loop and shall be installed in conduit when the distance from the bracket to the low voltage bus exceeds 450 mm.

Connections or riser wires to the assigned feeder conductors shall be made with compression connectors insulated with insulating covers.

In-line fuse holders and fuses shall be installed in the pole handhole and placed in an accessible location. For wooden poles, in-line fuse holder and fuses shall be installed at the point of connection.

617.07.07 Grounding

Grounding shall be according to OPSS 609.

For metal or concrete pole mounting, a #12 AWG insulated (green) stranded copper ground wire shall be installed between the luminaire housing ground terminal and the ground stud in the pole handhole.

For wooden pole mounting, a #12 AWG insulated (green) stranded copper ground wire shall be installed between the luminaire housing ground terminal and the system ground.

617.07.08 Replacing Luminaires

Existing luminaires shall be removed and new luminaires shall be installed according to the Contract Documents. Existing riser wires and luminaire ground wire shall be salvaged and connected to the new luminaires.

617.07.09 Relamping

When required, existing lamps shall be removed. The existing luminaires shall be thoroughly cleaned and new lamps shall be installed according to the Contract Documents.

617.07.10 Quality Control

617.07.10.01 Pre-Installation Testing and Inspection

Luminaires, brackets, socket setting, refractor type and ballast type shall be tested and inspected to ensure that they are according to the Contract Documents.

617.07.10.02 Proof of Performance Testing and Inspection

Luminaires shall be tested and inspected to ensure that they are levelled correctly and according to the Contract Documents. All lamps installed in luminaires shall have a minimum burning-in period of 100 nighttime hours prior to acceptance of the work by the Contract Administrator. All luminaire shielding shall be installed prior to the start of the burn-in period.

All tests required on the wiring system shall be according to OPSS 604.

617.07.11 Temporary Electrical Work

The work for temporary electrical installations shall be the same as for permanent installations of the same type of work, except the work shall include the removal of the installations when they are no longer required.

617.07.12 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

617.09 MEASUREMENT FOR PAYMENT

617.09.01 Actual Measurement

617.09.01.01 Roadway Lighting Luminaires and Bracket Assemblies

For measurement purposes, a count shall be made of the number of roadway lighting luminaires and bracket assemblies installed.

617.09.01.02 High Mast Lighting Luminaires

For measurement purposes, a count shall be made of the number of high mast lighting luminaires installed.

617.09.01.03 Floodlighting Luminaires and Bracket Assemblies

For measurement purposes, a count shall be made of the number of floodlighting luminaires and bracket assemblies installed.

617.09.01.04 Replace Roadway Lighting Luminaires

For measurement purposes, a count shall be made of the number of roadway lighting luminaires replaced.

617.09.01.05 Replace High Mast Lighting Luminaires

For measurement purposes, a count shall be made of the number of high mast lighting luminaires replaced.

617.09.01.06 Replace Floodlighting Luminaires

For measurement purposes, a count shall be made of the number of floodlighting luminaires replaced.

617.09.01.07 Relamp Roadway Lighting Luminaires

For measurement purposes, a count shall be made of the number of new lamps installed in existing roadway lighting luminaires.

617.09.01.08 Relamp High Mast Lighting Luminaires

For measurement purposes, a count shall be made of the number of new lamps installed in existing high mast lighting luminaires.

617.09.01.09 Relamp Floodlighting Luminaires

For measurement purposes, a count shall be made of the number of new lamps installed in existing floodlighting luminaires.

617.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

617.10 BASIS OF PAYMENT

617.10.01 Roadway Lighting Luminaires and Bracket Assemblies - Item
High Mast Lighting Luminaires - Item
Floodlighting Luminaires and Bracket Assemblies - Item
Replace Roadway Lighting Luminaires - Item
Replace High Mast Lighting Luminaires - Item
Replace Floodlighting Luminaires - Item
Relamp Roadway Lighting Luminaires - Item
Relamp High Mast Lighting Luminaires - Item
Relamp Floodlighting Luminaires - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

617.10.02 Roadway Lighting Luminaires and Bracket Assemblies (Temporary) - Item
Floodlighting Luminaires and Bracket Assemblies (Temporary) - Item
High Mast Lighting Luminaires (Temporary) - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Progress payments for the above tender items shall be based on the following percentages of the Contract price:

80% for supply and installation
20% for removal

TABLE 1
Lamps for Roadway Lighting

Lamp Type	Lamp Wattage	Lamp Nominal Operating Voltage	Lamp Finish	ANSI Lamp Designation
High Pressure Sodium (HPS)	100	55	Clear	S54-100
	150	55	Clear	S55-150
	200	100	Clear	S66-200
	200	100	Coated	S66/D-22
	250	100	Clear	S50-250
	310	100	Clear	S67-310
	400	100	Clear	S51-400
	600	105	Clear	S106-600
	750	120	Clear	S111-750
	1000	250	Clear	S52-1000

Appendix 617-A, November 2019
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Roadway lighting luminaire requirements. (617.05.01.01)

- High mast lighting luminaire requirements. (617.05.01.02)

- Floodlighting luminaire requirements. (617.05.01.03)

- Bracket type. (617.05.06)

- Floodlight bracket orientation. (617.07.04.02)

- Light distribution requirements. (617.07.05.01)

- High mast lighting horizontal and vertical orientation angles. (617.07.05.01)

The designer should determine if the following are required and, if they are, specify them in the Contract Documents:

- Luminaire shields. (617.07.05.01)

- Luminaire shield orientation. (617.07.05.01)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 2418.010	1.8m and 2.7m Steel Truss Bracket for Steel Poles
OPSD 2420.010	Aluminum Tapered Elliptical Bracket
OPSD 2421.010	Lamp Wattage Label for Luminaire
OPSD 2453.000	High Mast Lighting Pole, Luminaire and Handhole Orientation
OPSD 2453.060	High Mast Lighting Pole, Flood Light Luminaire Mounting Details
OPSD 2453.070	High Mast Lighting Pole, Luminaire Support Ring
OPSD 2453.090	High Mast Lighting Pole, Shroud
OPSD 2453.091	High Mast Lighting Pole, Shroud Details

CONSTRUCTION SPECIFICATION FOR TRAFFIC SIGNAL EQUIPMENT AND ELECTRICAL TRAFFIC CONTROL DEVICES

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620.09 **MEASUREMENT FOR PAYMENT**

620.10 **BASIS OF PAYMENT**

APPENDICES

620-A **Commentary**

620.01 SCOPE

This specification covers the requirements for the installation of traffic signal equipment and electrical traffic control devices.

620.01.01 Specification Significance and Use

This specification has been developed for use in municipal oriented Contracts. The administration, testing, and payment policies, procedures, and practices reflected in this specification correspond to those used by many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

620.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

620.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 603	Installation of Ducts
OPSS 604	Installation of Cable
OPSS 609	Grounding
OPSS 610	Removal of Electrical Equipment and Materials
OPSS 624	Traffic Signal Interconnection Equipment

Ontario Provincial Standard Specifications, Material

OPSS 2409	Traffic Signal Cable
OPSS 2410	Extra Low-Voltage Cable
OPSS 2460	Traffic Signal Arms, Brackets, Hangers, Fittings, and Hardware
OPSS 2461	Signal Heads
OPSS 2475	Uninterruptible Power Supply Systems for LED Traffic Signals

Ministry of Transportation Publications

Ontario Traffic Manual (OTM):
Book 12 - Traffic Signals

CSA Standards

C22.2 No. 41-13 (R2017)	Grounding and Bonding Equipment
C22.2 No. 45.2-08 (R2013)	Electrical Rigid Metal Conduit - Aluminum, Red Brass, and Stainless Steel
C22.2 No. 65-13	Wire Connectors
C22.2 No. 85-14	Rigid PVC Boxes and Fittings
C22.2 No. 197-M1983 (R2013)	PVC Insulating Tape
C22.2 No. 211.2-06 (R2016)	Rigid PVC (Unplasticized) Conduit
C57-16	Electric Power Connectors for Use in Overhead Line Conductors

Electrical Safety Authority (ESA)

Ontario Electrical Safety Code

Others

Ontario Highway Traffic Act, R.S.O. 1990, Chapter H.8
Transport Canada Guideline for Inspecting and Testing Pre-emption of Interconnected Traffic Control Signals and Railroad Crossing Warning Systems

620.03 DEFINITIONS

For the purpose of this specification, the definitions in the OTM Book 12 and the following definitions apply:

Auxiliary Signal Head means a traffic signal head installed as supplementary to the primary and secondary signal heads and that may be necessary due to local conditions.

Beaconing Actuation means the actuation of the audible signal when a pedestrian push button is pressed and held for a predefined period, typically 3 seconds.

Detection means the operation of a detector sensor unit in registering the presence or passage of a vehicle or pedestrian.

Highway Signal Head means a traffic signal head with a 300 mm diameter red lens and with 200 mm diameter amber and green lenses.

Oversize Highway Signal Head means a traffic signal head with 300 mm diameter red, amber, and green lenses.

Interconnection means the system of cables and devices that operate traffic signal controllers at consecutive intersections in a fixed or pre-programmed timing sequence.

Pedestrian Signal Head means a traffic signal head comprising of a walk and don't walk symbol mounted at a crosswalk.

Primary Signal Head means a traffic signal head mounted on the far right side of an intersection approach.

Secondary Signal Head means a traffic signal head mounted on the far left side or in the median of an intersection approach.

Signal Head means an assembly containing one or more signal displays.

Special Signal Head means a traffic signal head comprised of a combination of sections with red, amber, and green displays or sections with green and amber displays.

Standard Signal Head means a traffic signal head with 200 mm diameter red, amber, and green lenses.

Uninterruptible Power Supply means a backup power supply that supplies temporary power without an interruption in system operation in the event of a short-term loss of power from the local supply authority.

Vehicle Extension means the time, in seconds, added to the green interval to permit additional green time upon actuation by a vehicle approaching the intersection.

620.04 DESIGN AND SUBMISSION REQUIREMENTS

620.04.01 Submissions Requirements

620.04.01.01 Working Drawings and Service Manuals

Working Drawings and service manuals shall be submitted as specified in the Contract Documents.

620.05 MATERIALS

620.05.01 Traffic Signal Heads and Flasher Beacons

Traffic signal heads shall be according to OPSS 2461, OTM Book 12, and the Ontario Highway Traffic Act.

Flasher beacons shall be according to OPSS 2461.

620.05.02 Mast Arms, Brackets, and Signal Hangers

Mast arms, brackets, and signal hangers shall be according to OPSS 2460 and the Contract Documents.

620.05.03 Traffic Signal Cables

Traffic signal cables shall be according to OPSS 2409.

620.05.04 Electrical Insulating Tape

Electrical insulating tape shall be according to CSA C22.2 No. 197 and rated for 600 V and -10 to 90 °C working temperature.

620.05.05 Light Sources

620.05.05.01 Incandescent Lamps

Incandescent lamps shall be according to OPSS 2461.

620.05.05.02 LED Modules

LED modules shall be according to OPSS 2461.

620.05.06 Ducts and Fittings

Rigid PVC ducts and fittings shall be according to CSA C22.2 No. 211.2. Rigid aluminum ducts and fittings shall be according to CSA C22.2 No. 45.2.

620.05.07 Electrical Connectors

Wire connectors shall be of the insulated wing nut, vibration proof spring type, and shall be according to CSA C22.2 No. 65.

Cable connectors shall be according to CSA C22.2 No. 65 and CSA C57.

Mechanical connectors shall be according to CSA C22.2 No. 41.

620.05.08 Junction Boxes and Fittings

PVC junction boxes and fittings shall be according to CSA C22.2 No. 85.

620.05.09 Strapping

Stainless steel strapping and buckles shall have a minimum ultimate strength of 4.5 kN.

620.05.10 Traffic Signal Mounting Equipment

Fittings, accessories, and hardware shall be as specified in the Contract Documents.

620.05.11 Grommets

Grommets shall be rubber or neoprene sized to suit the aperture, metal thickness, and cable diameter.

620.05.12 Grounding Materials

Grounding materials shall be according to OPSS 609.

620.05.13 Controllers

Controllers shall be as specified in the Contract Documents.

620.05.14 Loop Detectors

Extra low-voltage cables for loop detectors shall be according to OPSS 2410.

620.05.15 Pedestrian Push Buttons

Pedestrian push buttons shall be as specified in the Contract Documents.

620.05.16 Accessible Pedestrian Signals

Accessible pedestrian signals shall be as specified in the Contract Documents.

620.05.17 Sealing Compound

Sealing compound shall be of the cold pumped type or hot poured type as specified in the Contract Documents.

620.05.18 Aerial Mounting Equipment

Fittings, accessories, and hardware shall be as specified in the Contract Documents.

620.05.19 Microloop Detectors

Microloop detectors shall be according to the manufacturer's specifications and as specified in the Contract Documents.

620.05.20 Microwave Detectors

Microwave detectors shall be according to the manufacturer's specifications and as specified in the Contract Documents.

620.05.21 Video Detectors

Video detectors shall be according to the manufacturer's specifications and as specified in the Contract Documents.

620.05.22 Variable Message Signs

Variable message signs shall be according to the manufacturer's specifications and as specified in the Contract Documents.

620.05.23 Advance Warning Signs

Advance warning signs shall be according to the manufacturer's specifications and as specified in the Contract Documents.

620.05.24 Traffic Signal Pre-Emption Equipment

Traffic signal pre-emption equipment shall be according to the manufacturer's specifications, as specified in the Contract Documents, and the specific requirements of the authority that is authorized to activate and use the pre-emption function.

620.05.25 Uninterruptible Power Supply Systems

Uninterruptible power supply systems shall be according to OPSS 2475.

620.07 CONSTRUCTION

620.07.01 General

General electrical work requirements shall be as specified in the Contract Documents.

The work shall include the supply, installation, modification, and testing of all materials and systems required to provide traffic signal systems, traffic control devices, and other devices that are fully functional and perform their intended function as specified in the Contract Documents.

620.07.02 Traffic Signals

620.07.02.01 Mast Arms

The attachment point of the mast arm on the pole shall be set to obtain the required clearance from finished grade to the bottom of the signal head. When two or more mast arms are mounted on the same pole, the clearance height of the primary signal head shall be set to obtain the required clearance height specified in the Contract Documents. Other mast arms with secondary or auxiliary signal heads shall be adjusted on the pole so that a minimum separation of one pole diameter is obtained between fittings or bolts touching the pole.

Holes for wooden pole mounting shall be drilled to accommodate the through bolts. Nuts shall be tightened to obtain a minimum wood compression of 3 mm under the washers.

Mast arm attachment to steel poles using U bolts or pole plates shall be tightened to a point when the pole just begins to deform.

Mast arms shall be installed perpendicular to the through lanes of traffic being served.

620.07.02.02 Traffic Signal Head Supports

Silicon based sealer shall be applied to the assembly as specified in the Contract Documents.

Traffic signal heads shall be supported as specified in the Contract Documents.

Traffic signal head supports shall be fastened onto the tenon of the mast arm or onto the traffic signal pole itself. Traffic signal head supports shall be adjusted and secured.

620.07.02.03 Double Arm Brackets

Double arm brackets shall be assembled on signal heads prior to pole mounting. The arm shall be installed in parallel alignment and all locknuts securely tightened.

Pole plates shall be mounted on the side of the pole so that the signal heads meet the required clearance height from finished grade. Pole plates shall be secured with stainless steel strapping that shall not overlap or secure any other equipment on the pole.

620.07.02.04 Signal Heads

Signal heads shall be installed facing the direction of approaching traffic. LED modules or incandescent lamps of the size and type specified in the Contract Documents shall be installed. Incandescent lamps shall be installed with positive electrical contact in the signal head lamp holders. Lamp holders for incandescent lamps shall be turned so that the gap in the lamp filament is facing upwards.

Signal heads shall be covered with opaque covers and remain securely in place until all tests have been completed and the signal heads are put into operation. Pedestrian signal heads shall be turned to face the pole prior to operation.

Signal heads shall be adjusted for maximum visibility and focusing prior to final tightening or sealing of hardware. Unused top and bottom hubs in signal heads shall be plugged with bird stops and the top hub shall have a gasket.

620.07.02.05 Wiring Apertures

Wiring apertures shall be drilled as required in metal poles. Apertures shall be located clear of the vertical seam and overlapping sections of sectional steel poles. Apertures shall be de-burred and painted with grey zinc rich paint. Grommets shall be installed after the paint is dry.

620.07.02.06 Pole Mounted Conduit Systems

Pole mounted conduit systems including rigid PVC junction boxes and all necessary fittings and hardware shall be installed when traffic signal equipment is to be installed on concrete or wooden poles. Conduit shall be installed in straight lengths to follow the taper of the pole using stainless steel strapping or galvanized steel two-hole clips secured by galvanized lag screws at 1.5 m maximum spacing. Offset bends shall be used when required to avoid pole attachments and other equipment. Conduits shall be kept free of kinks or scorch marks.

620.07.02.07 Wiring

Traffic signal cable shall be installed between the signal head and the pole handhole or the pole mounted PVC junction box. Wiring shall be run through the mast arms, signal hangers, and the upper arm of double arm brackets. A minimum length of 600 mm of riser cable shall be left in pole handholes.

Aerial cable from the PVC junction box to the signal head shall be installed according to OPSS 604.

Riser cables shall be connected to LED modules or incandescent lamp holder leads via terminal blocks or with insulated wing nut vibration proof spring connectors. Termination of spare conductors and handhole or junction box connections shall be made with insulated spring connectors. All insulated wire connectors shall be held in place with three half laps of electrical vinyl tape. Upon completion of connections, all conductors shall be neatly bundled together and secured with four laps of electrical vinyl tape.

Signal heads shall be bonded according to OPSS 609 and the Ontario Electrical Safety Code using the designated bonding conductor in the cable, and connected securely to the signal head and the pole ground stud or the system ground wire in PVC junction boxes.

Cables shall be identified at all access points and labelled as specified in the Contract Documents. Cables shall be identified using tags with permanent waterproof markings.

620.07.02.08 Optically Directed Signal Heads

Optically directed signal heads shall be installed according to the manufacturer's instructions. Signal heads shall be adjusted to focus along the designated roadways or traffic lanes.

620.07.02.09 Aerial Mounted Equipment

Aerial mounted equipment shall be installed using all fittings, hardware, PVC junction boxes, and accessories necessary for the mounting of equipment on aerial messenger cable systems. All compression nuts, lock nuts, and fitting hardware shall be securely tightened to prevent shifting of equipment by wind.

620.07.02.10 Equipment Modifications

Removal of existing equipment shall be according to OPSS 610 and as specified in the Contract Documents. Installation of new, refurbished, or modified equipment shall be done according to the requirements for installation of the particular items of equipment as described herein.

620.07.03 Traffic Control Devices

620.07.03.01 Flasher Beacons

Flasher beacons for post top mounting shall be aligned facing the direction of approaching traffic.

Flasher beacons for pole front or side mounting shall be aligned facing the direction of approaching traffic and mounted on double arm brackets or mast arms and signal hangers as specified in the Contract Documents.

Single or multiple cluster of flasher beacons for aerial mounting shall be arranged on the overhead support cable to provide the required visibility and clearances for each direction of approaching traffic to be controlled. Mounting hardware shall be securely tightened.

620.07.03.02 Flasher Mechanisms

Flasher mechanisms shall be mounted in enclosures with the accompanying conduit, conduit fittings, and wiring systems.

620.07.03.03 Sign Light Assemblies

Sign light assemblies shall be installed with rigid aluminum conduit and fittings, lamp holders, and lamps and shall be installed facing the direction of approaching traffic. Lengths of conduit shall be secured against fittings with lock nuts.

620.07.03.04 Internally Illuminated Signs

Internally illuminated signs shall be installed on double arm brackets, mast arms and signal hangers, or aerial support cables as specified in the Contract Documents.

620.07.03.05 Grounding

Traffic control devices shall be grounded according to OPSS 609.

620.07.03.06 Removals

Removals shall be according to OPSS 610.

620.07.04 Controllers

620.07.04.01 Controller Cabinets

620.07.04.01.01 Pole Mounted Controller Cabinets

Pole mounted controller cabinets shall be installed complete with mounting brackets, hardware, stainless steel strapping, and pole mounted conduits and fittings and shall be located and oriented as specified in the Contract Documents.

620.07.04.01.02 Pad Mounted Controller Cabinets

Pad mounted controller cabinets shall be installed complete with hardware and accessories and shall be located and oriented as specified in the Contract Documents.

A gasket shall be attached squarely and symmetrically on the bottom channel of the cabinet prior to installation with holes for mounting bolts drilled, when necessary.

A gasket with adhesive on one side shall be provided to install between the concrete pad and the bottom of the cabinet or base extension unit.

The cabinet enclosure shall include a main cabinet and a base extension unit. The top of the base extension unit shall match the bottom of the main cabinet. A gasket shall be installed between the main cabinet and the base extension unit. All stainless steel hardware to bolt the main cabinet together with the base extension unit shall be provided.

620.07.04.01.03 Pedestal Mounted Controller Cabinets

Pedestal mounted controller cabinets shall be installed complete with hardware and accessories and shall be located and oriented as specified in the Contract Documents.

620.07.04.01.04 Equipment Bonding

Equipment bonding shall be according to OPSS 609 and the Ontario Electrical Safety Code.

620.07.04.02 Controller Equipment

620.07.04.02.01 Shelf-Mounted and Rack-Mounted Equipment

Shelf-mounted and rack-mounted controller equipment shall be neatly and suitably arranged on the shelves or racks so that all preformed wiring harnesses are of adequate length to allow connections and may be trained to out-of-the-way locations. Similar items of equipment shall be grouped together. All equipment shall be installed with the front facing outward so that the main operational controls and switches are readily accessible.

620.07.04.02.02 Cabinet-Wall Mounted Equipment

Cabinet-wall mounted equipment shall be installed level and clear of nearby components. The equipment shall be bolted in place with minimum 5 mm diameter stainless steel machine bolts, nuts, and lock washers.

620.07.04.02.03 Identification of Equipment

All equipment shall be identified with permanent markings.

620.07.04.02.04 Security

Controller cabinets shall be kept locked at all times, except when work is being performed on the controller cabinet equipment. Upon completion of the work, all keys to the controller cabinet shall be given to the Contract Administrator.

620.07.04.02.05 Traffic Signal Control Programming and Timing

All controller and conflict monitor programming shall be installed and all timing controls, switches, and programming controls shall be set.

The Contract Administrator shall provide the traffic signal interval timing to the Contractor. The Contractor shall install the traffic signal timing into the traffic signal controller. The Contractor shall verify that the traffic signal timing is consistent and complete prior to installing it.

620.07.05 Activation Devices

620.07.05.01 Detector Loops

620.07.05.01.01 Loop Layout

Detector loops shall be accurately laid out on the pavement to the dimensions specified in the Contract Documents. Slot cutting lines shall be marked with non-permanent materials.

When the layout of a loop crosses a major pavement crack, butt or expansion joint, or irregularity, the treatment for the crossing shall be as specified in the Contract Documents.

620.07.05.01.02 Saw Cutting

The Contractor shall ensure that the temperature is within allowable limits prior to saw cutting and ensure that any dampness or precipitation can be successfully blown out of saw cut slots prior to and during installation.

Saw cutting of loop slots in pavement shall be in straight lines with slot depths and widths according to the dimensions specified in the Contract Documents. Corner cutting for slots shall be extended only far enough past each corner point to obtain the full depth of the slot. Slot crossing of pavement irregularities shall be constructed using additional widths and depths of slots as specified in the Contract Documents.

When specified in the Contract Documents, saw-cut marks shall be made on the curbs to indicate location of the loop.

620.07.05.01.03 Slot Preparation

Upon completion of saw cutting, the slot shall be cleaned with compressed air and dried by applying heat.

Corner of slot shall be rounded using hand tools. All slots and corners shall be examined for protrusions of sharp stone aggregates or debris that may damage the cable. Any such protrusions or debris shall be removed. Final slot preparation shall be done immediately prior to installation of the cable.

620.07.05.01.04 Flexible Duct Installation

A hole shall be drilled through the pavement to accommodate a flexible duct at the location specified in the Contract Documents.

All work for flexible duct installation, including earth excavation, backfill, removal, and restoration shall be according to OPSS 603.

620.07.05.01.05 Loop Cable

The loop shall be installed with the size, winding direction, configurations, number of turns, and type of cables as specified in the Contract Documents.

The loop cable end that progresses clockwise shall be marked at the splice point with two bands of colour contrasting electrical vinyl tape.

Each loop cable and extra low-voltage cable shall be identified with a vinyl sleeve wire marker in the splice point as specified in the Contract Documents.

Cable in slots shall be firmly and carefully tamped in place using a blunt instrument on each successive turn of cable. Cables shall be held in place to prevent floating using 25 mm lengths of foam backer rod at 600 mm intervals.

When cables are installed in slots crossing pavement irregularities, all cables shall be installed through split neoprene tubing.

Loop cables between the loop and the splice point, including those in the slot, shall be twisted together to form a consistent lay of 10 turns per metre. The entire loop and lead cable system shall be installed as a continuous and unspliced length of cable.

620.07.05.01.06 Sealing Compound

Sealing compound shall be installed in slots as specified in the Contract Documents.

Sealing compounds shall be installed in slots as protection for loop cables. Sealing compound shall be allowed to set according to the manufacturer's instructions prior to allowing vehicles to cross over the loop. Loop sealant shall be applied directly into the loop slot with no spillage. Spilled loop sealant or other excess loop sealant on the road surface that is not within the loop slot shall be removed from the road surface. Sealing compound shall be of the following types:

a) Cold Pumped Type

Cold pumped compounds shall be installed using a pressure pump or cartridge gun according to the manufacturer's instructions.

b) Hot Poured Type

Hot poured sealant shall be applied according to the manufacturer's recommendation. Hot poured sealant shall not be used when loops are to be installed in the binder course pavement prior to placement of the top course of pavement over the loops.

620.07.05.01.07 Splicing

Splices of cables shall be made only at the designated splice points. Cables shall be stripped of insulation by approximately 12 mm, butt spliced, soldered together, and covered with a resin or silicone material to produce a sealed connection.

620.07.05.02 Microloop Detectors

Microloop detectors shall be installed in underground ducts at the depths and locations specified in the Contract Documents. Microloops shall be connected to lead-in cable as specified in the Contract Documents.

Ducts for microloops and lead-in cables shall be installed by subsurface installation according to OPSS 603. Lead-in cables for microloops shall be installed according to OPSS 604.

620.07.05.03 Microwave Detectors

Microwave detectors shall be installed at locations and mounting heights specified in the Contract Documents. Microwave detectors shall be orientated and configured for operation according to the manufacturer's specifications and as specified in the Contract Documents.

All cabling and equipment required to transmit, receive, and process microwave detection signals shall be installed according to the manufacturer's specifications and as specified in the Contract Documents.

620.07.05.04 Video Detectors

Video detectors shall be installed at locations and mounting heights specified in the Contract Documents. Video detectors shall be orientated and configured for operation according to the manufacturer's specifications and as specified in the Contract Documents.

All cabling and equipment required to transmit, receive, and process video and video detection signals shall be installed according to the manufacturer's specifications and as specified in the Contract Documents.

620.07.05.05 Variable Message Signs

Variable message signs shall be installed at locations specified in the Contract Documents. Variable message signs shall be orientated and configured for operation according to the manufacturer's specifications and as specified in the Contract Documents.

All cabling and equipment required to transmit messages to the variable message signs shall be installed according to the manufacturer's specifications and as specified in the Contract Documents.

620.07.05.06 Advance Warning Signs

Advance warning signs shall be installed at locations specified in the Contract Documents. Advance warning signs shall be orientated and configured for operation according to the manufacturer's specifications and as specified in the Contract Documents.

All cabling and equipment required to transmit messages to the advance warning signs shall be installed according to the manufacturer's specifications and as specified in the Contract Documents.

620.07.05.07 Pedestrian Push Buttons

Pedestrian push buttons shall be installed at locations specified in the Contract Documents and include the installation of pedestrian push buttons and push button signs as specified in the Contract Documents.

Pedestrian push buttons and push button signs shall be mounted on the side of the pole so that the pedestrian signal push button sign arrow indicates the proper direction for which roadway crossing is required.

Pedestrian push buttons shall be installed with stainless steel self-tapping screws or stainless steel strappings. A wiring aperture shall be drilled in metal poles and fitted with a rubber grommet or a rigid conduit shall be installed on poles for wiring access.

Push buttons for metal poles shall be installed as specified in the Contract Documents with an integral sign frame or separately mounted with stainless steel strappings or screws.

620.07.05.08 Accessible Pedestrian Signals

Accessible pedestrian signals shall be installed according to all applicable laws and regulations.

620.07.06 Traffic Signal Pre-Emption Equipment

Traffic signal pre-emption equipment shall be installed according to the manufacturer's instructions and as specified in the Contract Documents. Pre-emption equipment shall be set up to operate according to the manufacturer's specifications, as specified in the Contract Documents, and the specific requirements of the authority that is authorized to activate and use the pre-emption function.

620.07.07 Traffic Signal Interconnection Equipment

Traffic signal interconnection equipment shall be installed according to OPSS 624 and as specified in the Contract Documents.

620.07.08 Traffic Signal Control Equipment Supplied by Owner

When the Owner supplies the traffic signal control equipment, the equipment shall be loaded and transported from the Owner's premises specified in the Contract Documents. The Contractor shall ensure that all components are safely connected, secured, and packaged prior to transporting the equipment.

620.07.09 Uninterruptible Power Supply Systems

Uninterruptible power supply equipment shall be installed and adjusted according to the manufacturer's instructions and as specified in the Contract Documents.

620.07.10 Quality Control

620.07.10.01 General

The Contract Administrator shall be notified of the time and location of all inspection and testing 3 Business Days prior to the start of the work and confirm that the work shall be performed as scheduled 24 hours prior to the start of the work.

The work shall be inspected and tested 3 Days prior to the actual turn on of the signals to ensure that it is according to the requirements as specified in the Contract Documents.

A minimum of 72 hours prior to the scheduled activation of each traffic signal, the Contractor shall coordinate and attend an on-site quality control meeting with the Contract Administrator.

Upon completion of installations and testing, a visual check shall be made of the controller cabinet to ensure proper operation of the equipment.

All test results shall be submitted to the Contract Administrator.

620.07.10.02 Test Plans

A test plan shall be submitted to the Contract Administrator documenting how the traffic signals and electrical traffic control devices will be tested. The test plan shall be submitted to the Contract Administrator prior to any installation work and a minimum of 30 Business Days prior to the start of any testing.

The Contractor shall make additions or modifications to the test plan as specified by the Contract Administrator. Testing shall not commence until the test plan has been accepted by the Contract Administrator. Once accepted, the traffic signals and traffic control devices shall be tested according to the accepted test plan and as specified in the Contract Documents.

As a minimum, the test plan shall include a pre-installation test plan and a proof of performance test plan.

Once accepted by the Contract Administrator, the accepted test plan shall form part of the Contract Documents.

620.07.10.03 Pre-Installation Testing and Inspection

Actuation devices and connection components shall be inspected prior to installation to ensure that they meet the requirements as specified in the Contract Documents.

Traffic signal controllers and components shall be inspected prior to installation to ensure that they meet the requirements as specified in the Contract Documents.

The Contractor shall be responsible for ensuring that all controller and conflict monitor programming are installed and that all timing controls, switches, and programming controls are properly set.

Signal heads, mast arms, traffic signal head supports, double arm brackets, and connection components shall be inspected prior to installation to ensure that they meet the requirements as specified in the Contract Documents.

620.07.10.03.01 Traffic Signal Control Equipment

Traffic signal control cabinets complete with traffic signal control equipment shall be tested and inspected. The functionality and performance of each component shall be tested and confirmed to operate according to the manufacturer's specifications and as specified in the Contract Documents.

The entire traffic signal control equipment shall be tested with the traffic signal control equipment installed within the cabinet and all programming, timing, switches, and controls installed and set. The functionality and performance of the traffic signal control equipment as a complete system shall be tested and confirmed to operate according to the traffic signal timing plan, the manufacturer's specifications, and as specified in the Contract Documents.

If the traffic signal control equipment or any part thereof fails to operate correctly, the deficiency shall be corrected and the testing and inspection repeated in full.

620.07.10.03.02 Traffic Signal Equipment

The functionality and performance of each piece of traffic signal equipment shall be tested and inspected and confirmed to operate according to the manufacturer's specifications and as specified in the Contract Documents.

If the traffic signal equipment or any part thereof fails to operate correctly, the deficiency shall be corrected and the testing and inspection repeated in full.

620.07.10.03.03 Electrical Traffic Control Devices

The functionality and performance of each electrical traffic control device shall be tested and inspected and confirmed to operate according to the manufacturer's specifications and as specified in the Contract Documents.

If the electrical traffic control device or any part thereof fails to operate correctly, the deficiency shall be corrected and the testing and inspection repeated in full.

620.07.10.03.04 Controllers

Pre-shipping shop tests are required prior to transporting the controller to the Working Area. When the Owner supplies the controller, the tests shall be carried out by the Owner.

The following pre-installation tests are required:

a) Cabinet Assembly and Components

A visual check shall be made to ensure that all components necessary to the complete controller are present and that all pre-assembled equipment is securely mounted and connected.

b) Circuit Output

The output terminal board voltage shall be tested for 108 V minimum output from load switches and for proper terminal assignment according to the manufacturer's wiring diagram.

c) Programming

With the actual phase timing for the intended intersection in operation, the controller programming shall be tested to ensure that the intended operation is accomplished. This test shall include all required combinations of actuation and recall settings together with any special features such as advance green, phase skip, pre-emption, or coordination.

d) Interval Sequence

With the proper programming for the intended intersection in operation, but with modified timing values suitable to test conditions, the controller unit shall be cycled through all phases for a minimum of 24 hours. Controller output shall be tested using a test board with indicator lights to ensure that the proper phases and phase intervals appear in the correct sequence. The testing shall be conducted using either a 120 V test board wired to the output side of the load switches or by a 24 V test board wired to the input side of the load switches. Test results shall be confirmed a minimum of 6 times.

e) Actuation

With an appropriate test board, the effect of detection devices and pedestrian push buttons in entering a call to the controller unit shall be tested. All modes of detector sensor unit program and vehicle extension calls shall be tested. Tests shall confirm that all calls are registered, activated, and are associated with the correct traffic phase.

f) Conflict Monitors

Conflict monitors shall be tested according to the manufacturer’s recommendations. All flash and reset functions shall be tested.

g) Flashers

The output of flasher units and flash transfer relays shall be tested for proper functioning over a two hour period.

h) Recall

Recall switch functions for each phase shall be tested to ensure that the controller recalls to the phase selected and remains on hold in the absence of a call on an opposing phase.

i) Manual Override Controls

Manual override controls shall be tested for proper operation under all possible switching combinations.

j) Environmental Controls

The heater element and circuitry shall be tested for continuity and proper resistance. The ventilation fan shall be checked for proper operation in conjunction with the thermostat control system. If the average temperature during the installation period is below 5 °C, the cover plate shall be installed over the louvres and the heater circuit shall be prepared for operation.

620.07.10.04 Proof of Performance Testing and Inspection

The work shall be inspected and tested a minimum of 3 Business Days prior to the actual turn on of the signals to ensure that it is according to the requirements as specified in the Contract Documents. In particular, and without limiting the foregoing, ensure all components are installed, tested, and proven to perform as specified in the Contract Documents and that all cables are energized and in working order and that the signal timing is consistent and complete, without activating the traffic signals for public display.

All proof of performance testing and inspection shall be performed on site with all signal heads covered with an opaque covering and all pedestrian signal heads turned to face the pole to which they are attached.
All traffic signal cable circuits shall be tested according to OPSS 604.

Each signal display shall be inspected and tested for correct phase connection and operation as specified in the Contract Documents.

Detection and actuation devices shall be tested and inspected for correct operation according to the manufacturer's specifications and as specified in the Contract Documents. This testing shall include observation of all calls generated to verify that they are registered and activated.

Traffic signal timing shall be verified to be consistent and complete. With the proper programming and signal timing in operation and with all system components and circuits connected, the traffic signal system shall be cycled through all of its phases and operations.

620.07.10.04.01 Detector Loops

Loop wiring shall be tested for continuity, for leakage to ground, and for inductance at the controller cabinet. Resistance to ground shall be 10 mega ohm or greater. Inductance shall be within 25% of the value specified in the Contract Documents using a 100 kHz signal at 5 V.

Any detector loop required to be replaced shall be removed from the original slot and a new detector loop shall be installed in the original slot or installed in a re-cut slot. The new detector loop shall be installed with new wiring and sealing compound and retested.

All test results shall be submitted to the Contract Administrator.

620.07.10.04.02 Microloop Detection Systems

Microloop detection systems shall be tested to confirm that the microloop detection equipment is accurately detecting vehicles and transmitting calls to the controller. Microloop detection systems shall be tested according to the manufacturer's specifications and as specified in the Contract Documents.

620.07.10.04.03 Microwave Detection Systems

Microwave detection systems shall be tested to confirm that the microwave detection equipment is accurately detecting vehicles and transmitting calls to the controller. Microwave detection systems shall be tested according to the manufacturer's specifications and as specified in the Contract Documents.

620.07.10.04.04 Video Detection Systems

Video detection systems shall be tested to confirm that the video detection equipment is accurately detecting vehicles and transmitting calls to the controller. Video detection systems shall be tested according to the manufacturer's specifications and as specified in the Contract Documents.

620.07.10.04.05 Variable Message Sign Systems

Variable message sign systems shall be tested to confirm that messages are accurately transmitted to the variable message signs and that the messages are displayed correctly. Variable message sign systems shall be tested according to the manufacturer's specifications and as specified in the Contract Documents.

620.07.10.04.06 Advance Warning Sign Systems

Advance warning sign systems shall be tested to confirm that the signs activate and deactivate at the correct points in the cycle of traffic control signal indications and that the advance warning signs activate and display correctly. Advance warning sign systems shall be tested according to the manufacturer's specifications and as specified in the Contract Documents.

620.07.10.04.07 Pedestrian Push Buttons

Upon completion of the installation of the pedestrian push buttons, the system shall be tested at the controller cabinet.

620.07.10.04.08 Accessible Pedestrian Signals

Upon completion of the installation of the accessible pedestrian signals, the system shall be tested for proper actuation and operation.

620.07.10.04.09 Traffic Signal Pre-Emption Equipment

Traffic signal pre-emption equipment shall be tested to confirm that each pre-emption system (i.e., railway, emergency vehicles, and transit) works correctly and performs its intended function. Pre-emption equipment shall be tested to confirm that pre-emption requests are served in the following order of priority:

a) Railway

b) Emergency Vehicles

c) Transit

620.07.10.04.09.01 Railroad

Upon completion of the railroad pre-emption installation, the pre-emption system shall be tested according to Transport Canada Guideline for Inspecting and Testing Pre-emption of Interconnected Traffic Control Signals and Railroad Crossing Warning Systems.

620.07.10.04.09.02 Emergency Vehicles

Testing of pre-emption equipment for emergency vehicles shall be coordinated with the emergency services that will use this pre-emption function. Emergency services (e.g., fire and ambulance) shall be present for the testing of this pre-emption equipment.

620.07.10.04.09.03 Transit

Upon completion of the transit signal pre-emption installation, the pre-emption system shall be tested with the assistance of the transit authority to confirm the correct operation of the transit signal pre-emption devices and algorithm.

620.07.10.04.10 Controllers

620.07.10.04.10.01 General

Field tests are required upon completion of the installation of the controller. The controller shall be allowed to operate functionally only after all testing has been completed and all components are operational.

620.07.10.04.10.02 Signal Cable

All traffic signal cable circuits shall be tested according to OPSS 604.

620.07.10.04.10.03 Interval Sequence

With the proper programming and timing functions in operation, the controller shall be cycled through all phases with all signal circuits connected and with signal heads covered.

620.07.10.04.10.04 Actuation

All calls shall be observed to be registered and activated. Actuation equipment shall be tested.

620.07.10.04.11 Uninterruptible Power Supply Systems

Uninterruptible power supply systems shall be tested to confirm that the system operation continues without interruption when there is an interruption of power from the local supply authority. The duration of operation on the uninterruptible power supply system shall be confirmed to be according to the manufacturer's specifications and as specified in the Contract Documents.

620.07.10.04.12 System Proof of Performance Testing and Inspection

The work shall be inspected and tested to ensure that the work is according to the requirements as specified in the Contract Documents. In particular, and without limiting to the foregoing, all components are installed, tested, and proven as specified in the Contract Documents and that all cables are energized and in working order without activating the traffic signals for public display.

The complete traffic signal system, including the traffic signal control system, shall be inspected and tested to verify that the complete integrated system operates correctly, safely, and as specified in the Contract Documents.

620.07.11 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

620.08 QUALITY ASSURANCE

Equipment and Materials, as supplied by the Contractor, are subject to inspection by the Contract Administrator prior to installation.

Equipment requiring the submission of Working Drawings and service manuals as specified in the Contract Documents may be inspected by the Contract Administrator prior to shipping from the manufacturer's factory or at the supplier's place of business. The Contractor shall inform the Contract Administrator when the equipment fabrication is complete and shall make suitable arrangements for any required inspection.

All electrical installation work is subject to random inspection by the Contract Administrator. The Contract Administrator may witness any testing performed by the Contractor during installation.

620.09 MEASUREMENT FOR PAYMENT

620.09.01 Actual Measurement

620.09.01.01

Loop Detectors
Microloop Detectors
Microwave Detectors
Video Detectors
Pedestrian Push Buttons
Traffic Actuation Equipment
Traffic Signal Controllers
Pedestal Mounted Traffic Signal Controllers
Traffic Signal Head Supports
Single Member Arms and Signal Hangers
Double Arm Brackets
Highway Signal Heads
Oversize Highway Signal Heads
Special Signal Heads
Standard Signal Heads
Pedestrian Signal Heads
Single Signal Head Sections
Optically Directed Signal Heads
Flasher Beacons
Flasher Mechanisms
Sign Light Assemblies
Internally Illuminated Signs
Variable Message Signs
Advance Warning Signs
Accessible Pedestrian Signals

For measurement purposes, a count shall be made of the number of each of the above types of traffic signal equipment or traffic control device installed.

620.09.01.02

Traffic Signal Controller Modifications (Intersection Locations)
Traffic Signal Equipment Modifications (Intersection Locations)

For measurement purposes, a count shall be made of the number of each of the above types of traffic signal equipment modified.

620.09.01.03 Uninterruptible Power Supply Systems

For measurement purposes, a count shall be made of the number of uninterruptible power supply systems installed.

620.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

620.10 BASIS OF PAYMENT

620.10.01 Loop Detectors - Item
Microloop Detectors - Item
Microwave Detectors - Item
Video Detectors - Item
Pedestrian Pushbuttons - Item
Traffic Actuation Equipment - Item
Traffic Signal Controllers - Item
Pedestal Mounted Traffic Signal Controllers - Item
Traffic Signal Controller Modifications (Intersection Locations) - Item
Traffic Signal Equipment Modifications (Intersection Locations) - Item
Traffic Signal Head Supports - Item
Single Member Arms and Signal Hangers - Item
Double Arm Brackets - Item
Highway Signal Heads - Item
Oversize Highway Signal Heads - Item
Special Signal Heads - Item
Standard Signal Heads - Item
Pedestrian Signal Heads - Item
Single Signal Head Sections - Item
Optically Directed Signal Heads - Item
Flasher Beacons - Item
Flasher Mechanisms - Item
Sign Light Assemblies - Item
Internally Illuminated Signs - Item
Variable Message Signs - Item
Advance Warning Signs - Item
Accessible Pedestrian Signals - Item
Uninterruptible Power Supply Systems - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

620.10.02 Traffic Signal Equipment - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work of installing all traffic signal equipment.

620.10.03 Traffic Control Devices - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work of installing all traffic control devices.

620.10.04 Rock Excavation

Payment for rock excavation shall be according to OPSS 603.

Appendix 620-A, April 2018
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Traffic signal mounting equipment fittings, accessories, and hardware specifications. (620.05.10)
- Controller specifications. (620.05.13)
- Pedestrian push button specifications. (620.05.15)
- Aerial mounting equipment fittings, accessories, and hardware specifications. (620.05.18)
- Microloop detector specifications. (620.05.19)
- Microwave detector specifications. (620.05.20)
- Video detector specifications. (620.05.21)
- Variable message sign specifications. (620.05.22)
- Advance warning sign specifications. (620.05.23)
- Traffic signal pre-emption equipment specifications. (620.05.24)
- Uninterruptible power supply system specifications. (620.05.25)
- Primary traffic signal head clearance height. (620.07.02.01)
- Sealer requirement for traffic signal head assemblies. (620.07.02.02)
- Size and type of LED modules or incandescent lamps to be installed in the signal heads. (620.07.02.04)
- Labelling requirement for cables. (620.07.02.07)
- Existing equipment to be removed for existing equipment modification. (620.07.02.10)
- Internally illuminated sign installation specifications. (620.07.03.04)
- Location and orientation of pole mounted controller cabinets. (620.07.04.01.01)
- Location and orientation of pad mounted controller cabinets. (620.07.04.01.02)
- Location and orientation of pedestal mounted controller cabinets. (620.07.04.01.03)
- Location and size of detector loops. (620.07.05.01.01)

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- Treatment for loops crossing major cracks, butt or expansion joints, or irregularities. (620.07.05.01.01)
- Loop saw cut depths, width, and length dimensions. (620.07.05.01.02)
- Location of flexible ducts for detector loops. (620.07.05.01.04)
- Size, winding direction, configurations, number of turns, and type of cable for detector loops. (620.07.05.01.05)
- Identification markings for loop and extra low-voltage cables. (620.07.05.01.05)
- Location of sealing compound to be installed for loop cable slots. (620.07.05.01.06)
- Depth and location of microloop detectors. (620.07.05.02)
- Installation specifications for microloop detectors and type of lead-in cable. (620.07.05.02)
- Location and mounting height of microwave detectors. (620.07.05.03)
- Orientation, configuration, and installation specifications for microwave detectors. (620.07.05.03)
- Location and mounting height of video detectors. (620.07.05.04)
- Orientation, configuration, and installation specifications for video detectors. (620.07.05.04)
- Location of variable message signs. (620.07.05.05)
- Orientation, configuration, and installation specifications for variable message signs. (620.07.05.05)
- Location of advance warning signs. (620.07.05.06)
- Orientation, configuration, and installation specifications for advance warning signs. (620.07.05.06)
- Location of pedestrian push buttons and pedestrian push button sign specifications. (620.07.05.07)
- Installation specifications for push buttons on metal poles. (620.07.05.07)
- Installation and setup specifications for traffic signal pre-emption equipment. (620.07.06)
- Installation specifications for traffic signal interconnection equipment. (620.07.07)
- Installation and adjustment specifications for uninterruptible power supply systems. (620.07.09)
- Traffic signal control equipment operation details. (620.07.10.03.01)
- Traffic signal equipment operation details. (620.07.10.03.02)
- Electrical traffic control device operation details. (620.07.10.03.03)
- Signal display performance details. (620.07.10.04)
- Detection and actuation device testing requirements. (620.07.10.04)
- Inductance value for detector loop testing. (620.07.10.04.01)

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- Microloop detection system operation details. (620.07.10.04.02)

- Microwave detection system operation details. (620.07.10.04.03)

- Video detection system operation details. (620.07.10.04.04)

- Variable message sign system operation details. (620.07.10.04.05)

- Advance warning sign system operation details. (620.07.10.04.06)

- Uninterruptible power supply system operation details. (620.07.10.04.11)

The designer should determine if the following are required and, if so, specify them in the Contract Documents:

- Beaconing actuation for accessible pedestrian signals. (620.05.16)

- Additional orientation guides for accessible pedestrian signals. (620.05.16)

- Additional accessible pedestrian signal features. (620.05.16)

- Saw-cut marks on curb to indicate loop location. (620.07.05.01.02)

- Supply of traffic signal control equipment by owner and location of control for pickup. (620.07.08)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 2011.701	General Symbols, Traffic Actuation Devices
OPSD 2200.041	Concrete Footing for 1.5m Base Mounted Pedestrian Pushbutton Pole
OPSD 2232.010	Sectional Steel Pole with Brackets, Luminaire, and Traffic Signal Head
OPSD 2235.010	Pole Guying Details
OPSD 2236.010	Wooden Pole and Anchorage Settings in Solid Rock 1
OPSD 2236.020	Wooden Pole and Anchorage Settings in Solid Rock 2
OPSD 2238.010	Wooden Pole in Earth
OPSD 2240.010	Wooden Pole with Elliptical Bracket, Overhead and Underground Circuits
OPSD 2242.010	Wooden Pole with Neutral Supported Cable
OPSD 2242.020	Wooden Poles with Aerial Signal Cables Lashed on Messenger
OPSD 2245.010	Installation of Aerial Cable Systems
OPSD 2245.020	Minimum Vertical Clearances for Aerial Cable Systems
OPSD 2250.010	Aluminum Tapered Elliptical Brackets on Metal and Concrete Poles, Mounting Details

2500 Series Electrical Drawings

CONSTRUCTION SPECIFICATION FOR INSTALLATION OF SECTIONAL STEEL HIGH MAST LIGHTING POLES

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630-A **Commentary**

630.01 SCOPE

This specification covers the requirements for the installation of sectional steel high mast lighting poles complete with raising and lowering equipment, including mechanical and electrical components.

630.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

630.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

630.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Material

OPSS 2471 Sectional Steel High Mast Lighting Poles
OPSS 2476 Raising and Lowering Equipment for High Mast Lighting Poles

CSA Standards

S6-14 Canadian Highway Bridge Design Code

630.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Certificate of Conformance means a document issued by the Quality Verification Engineer confirming that the specified components of the Work are in general conformance with the requirements of the Contract Documents.

Engineer means a professional engineer licensed by the Professional Engineers Ontario to practice in the Province of Ontario.

Quality Verification Engineer (QVE) means an Engineer retained by the Contractor qualified to provide the services specified in the Contract Documents.

630.04 DESIGN AND SUBMISSION REQUIREMENTS

630.04.01 Submission Requirements

630.04.01.01 Assembly of Sectional Steel High Mast Lighting Poles

The Contractor shall submit installation drawings, calculations, and procedures to the Contract Administrator at least 14 Days prior to the commencement of scheduled start of pole assembly for approval. An Engineer shall affix his or her seal and signature on the installation drawings, calculations, and procedures verifying that they are consistent with the Contract Documents and sound engineering practices.

These installation drawings, calculations, and procedures shall include all details of equipment to be used in jacking the sections together and lifting the assembled pole, including placing and securing it on the anchorage assembly.

630.04.01.02 Training Certificate

A certificate of training from the manufacturer of the high mast lighting raising and lowering equipment for each person who will be doing the installation work shall be submitted to the Contract Administrator. The certificates shall be submitted 14 Days prior to the commencement of the installation work, and the work shall not proceed until the certificates are accepted by the Contract Administrator. Training certificates that are 5 years old or more shall not be accepted.

The training certificate shall state that the manufacturer certifies that the individual has successfully completed an in-depth training course in the following areas:

a) Assembly of the pole sections.

b) Assembly of the raising and lowering equipment.

c) Operation of the raising and lowering equipment.

d) Installation of high mast poles and lighting equipment.

e) Levelling of the luminaire ring assembly.

f) Inspection of high mast poles and lighting equipment.

g) Maintenance and repair techniques for sectional steel high mast lighting equipment.

h) Safety procedures.

The training certificate shall be dated and signed by officers of the manufacturer and shall indicate the dates that the training was given.

630.05 MATERIALS

630.05.01 Sectional Steel High Mast Lighting Poles

Sectional steel high mast lighting poles shall be according to OPSS 2471.

630.05.02 Raising and Lowering Equipment

Raising and lowering equipment shall be according to OPSS 2476.

630.07 CONSTRUCTION

630.07.01 General

General requirements for electrical work shall be as specified in the Contract Documents.

630.07.01.01 Ordering Sectional Steel High Mast Lighting Poles and Raising and Lowering Equipment

Immediately following the award of the Contract, the high mast lighting poles and the raising and lowering equipment shall be ordered, as required for this Contract. All necessary measures shall be taken to ensure sectional steel high mast lighting poles and the raising and lowering equipment are 100% compatible and fully functional.

Verification of the delivery dates of the high mast lighting poles and the raising and lowering equipment shall be obtained from the suppliers and submitted to the Contract Administrator within 72 hours after the award of the Contract.

Timely and accurate communication shall be maintained with both the Owner and the suppliers regarding the delivery, schedules, and requirements for the high mast lighting poles and the raising and lowering equipment.

Delivery and off-loading of the sectional steel high mast lighting poles and the raising and lowering equipment shall be completed in a timely and efficient manner.

630.07.02 Sectional Steel High Mast Lighting Poles and Equipment

630.07.02.01 Assembly of Sectional Steel High Mast Lighting Poles

The lifting equipment used in contact with the pole sections shall be non-abrasive in nature.

Sectional steel high mast lighting poles shall be assembled so that all sections for individual poles are matched as fabricated. The completed sectional steel high mast lighting pole shall be according to the overall tolerances specified in the Contract Documents.

630.07.02.02 Raising and Lowering Equipment

The raising and lowering equipment and the mechanical and electrical components shall be installed according to the manufacturer's specifications and recommendations.

The raising and lowering equipment manufacturer shall be present during the equipment installation to ensure proper assembly procedures and commissioning.

630.07.02.03 Pole Installation

At least 14 Days prior to the start of pole installation, the Contract Administrator shall be informed, in writing, of the pending operation.

The anchorage setting templates shall be removed prior to installation of lighting poles.

The pole shall be installed plumb, with the base plate positioned and the door orientated as specified in the Contract Documents. The pole shall have adequate support during installation. The pole shall not be considered self-supporting until all fasteners in the base are tightened by the turn-of-nut method according to CSA S6.

A 12 mm square, welded, 19 AWG galvanized steel metal mesh shall be placed around the outside circumference of the anchor bolt circle, between the pole base plate and the footing after pole installation is completed.

The orientation of the high mast lighting pole shall be as specified in the Contract Documents.

630.07.02.04 High Mast Lighting Equipment

High mast lighting equipment shall be installed as specified in the Contract Documents.

630.07.03 Quality Control

630.07.03.01 Pre-Installation Testing and Inspection

The pre-installation testing and inspection of the high mast lighting pole complete with raising and lowering equipment, including mechanical and electrical components, shall be according to manufacturer's specification and the Contract Documents.

A letter of compliance from the manufacturer of the sectional steel high mast lighting pole equipment, certifying that the sectional steel high mast lighting pole equipment is according to the Contract Documents shall be submitted to the Contract Administrator by the Contractor.

Testing on the torque limiter shall be conducted on the internal drive raising and lowering equipment and on the portable power drill for the external drive raising and lowering equipment unit. The Contractor shall ensure that the torque limiter is set and functions according to the manufacturer's recommendations. The cord connecting the control to each raising and lowering motor or portable power drill shall be a minimum length of 13 m.

630.07.03.02 Proof of Performance Testing and Inspection

The ring assembly, including luminaires, and the raising and lowering equipment shall be fully raised, latched, unlatched, and fully lowered a minimum of five times for each installed sectional steel high mast lighting pole. After each raising and lowering sequence, every piece of the raising and lowering equipment shall be inspected to ensure that all components are functioning properly and are not damaged. The cables inside the pole shall be inspected. Twisted cables shall be untwisted prior to each subsequent raising and lowering sequence.

The following shall be inspected:

a) Winch gear and housing.

b) Winch cable.

c) Supporting cables.

d) Power cable.

e) Ring assembly.

f) Latching system.

If problems or deficiencies occur during the testing, the test shall be stopped and the problem or deficiency corrected. Once the problem or deficiency has been corrected, the testing process of the pole and associated material shall be repeated in full.

Each ring assembly and supporting cable shall be inspected and adjusted to ensure that the ring is level.

630.07.03.02.01 Certificate of Conformance

A Certificate of Conformance shall be submitted to the Contract Administrator upon completion of the work. The Quality Verification Engineer shall affix his or her seal and signature to the completed Certificate of Conformance confirming the following:

a) All of the high mast equipment at each high mast pole was tested and inspected.

b) The high mast lighting raising and lowering equipment is in general conformance with the requirements of the Contract Documents.

c) Each sectional steel high mast lighting pole has been installed plumb with the base plate positioned as specified in the Contract Documents.

d) Each sectional steel high mast lighting pole and raising and lowering equipment passed the proof of performance testing and inspection.

e) The torque limiter has been fully tested and verified to be fully functional according to the manufacturer's recommendations and the Contract Documents.

f) The sectional steel high mast lighting pole jacking and installation procedures have been carried out according to the installation drawings, calculations, and procedures.

g) At the end of the testing at each sectional steel high mast lighting pole, the ring assembly has been levelled, raised to the top of the pole, and fully and properly docked and latched to the head frame assembly at the top of the pole.

630.07.04 Document Submission

The service manual for the high mast lighting equipment shall document in detail the installation and operation of the high mast lighting equipment and components. It shall include clear and detailed illustrations indicating layouts of controls, displays, schematic and wiring diagrams, and other information required to correctly operate a fully assembled and operational high mast lighting unit, as well as the maintenance and service aspects of individual components.

The service manual for the high mast lighting equipment shall include part numbers and settings and options of installation and operation. The manual shall provide sections that completely describe the theory of operation using block diagrams, wiring and schematic diagrams, diagnostic and repair procedures, assembly instructions and drawings, component layout drawings, and acceptable manufacturers and suppliers of miscellaneous component parts.

Each manual for the high mast lighting equipment shall detail all major assembling, adjusting, and aligning procedures and identify all acceptable tolerances or variances. Manuals shall also include:

a) Detailed specifications of major components.

b) Copies of the Working Drawing specified in OPSS 2471 and OPSS 2476 reduced to 8½ x 11" paper format.

c) Component warranty certificates.

d) Operating instructions.

e) All other relevant documents or drawings.

630.07.05 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

630.08 QUALITY ASSURANCE

The Owner may make random inspections of individual high mast lighting poles, visually check for proper assembly with related equipment, and witness the raising and lowering of the ring assembly.

630.09 MEASUREMENT FOR PAYMENT

630.09.01 Actual Measurement

630.09.01.01 25 m Sectional Steel High Mast Lighting Poles and Equipment
30 m Sectional Steel High Mast Lighting Poles and Equipment
35 m Sectional Steel High Mast Lighting Poles and Equipment
40 m Sectional Steel High Mast Lighting Poles and Equipment
45 m Sectional Steel High Mast Lighting Poles and Equipment

For measurement purposes, a count shall be made of the number of each size of sectional steel high mast lighting poles and equipment installed.

630.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clause under Actual Measurement.

630.10 BASIS OF PAYMENT

630.10.01 25 m Sectional Steel High Mast Lighting Poles and Equipment - Item
30 m Sectional Steel High Mast Lighting Poles and Equipment - Item
35 m Sectional Steel High Mast Lighting Poles and Equipment - Item
40 m Sectional Steel High Mast Lighting Poles and Equipment - Item
45 m Sectional Steel High Mast Lighting Poles and Equipment - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Progress payments shall be based on the following percentages of the Contract price for milestones accepted by the Contract Administrator:

35% for delivery of all high mast lighting poles and equipment
5% for certificate of training
20% for installation of all high mast lighting poles and equipment
40% for completed and signed Certificate of Conformance for all High Mast Lighting Poles and Equipment

Appendix 630-A, November 2016
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Tolerances for the assembled sectional steel high mast pole. (630.07.02.01)

- Base plate positioning, door orientation, and pole orientation. (630.07.02.03)

- High mast lighting equipment installation requirements. (630.07.02.04)

- Pre-installation testing and inspection requirements. (630.07.03.01)

- Raising and lowering equipment requirements. (630.07.03.02.01)

- Torque limiter requirements. (630.07.03.02.01)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 2450.011	High Mast Lighting Pole, 25, 30, and 35 m 8-Sided Pole
OPSD 2450.021	High Mast Lighting Pole, 40 and 45 m 12-Sided Pole
OPSD 2453.000	High Mast Lighting Pole, Luminaire and Handhole Orientation
OPSD 2453.001	High Mast Lighting Pole, Luminaire and Handhole Orientation for Median Mounted Poles
OPSD 2453.010	High Mast Lighting Pole, Cable Holder and Storage Hook Details
OPSD 2453.020	High Mast Lighting Pole, Handhole Cover Hinges, Latches, and Padlock
OPSD 2453.050	High Mast Lighting Pole, Nameplate Details
OPSD 2453.060	High Mast Lighting Pole, Flood Light Luminaire Mounting Details
OPSD 2453.070	High Mast Lighting Pole, Luminaire Support Ring
OPSD 2453.080	High Mast Lighting Pole, Head Frame and Ring Assembly
OPSD 2453.090	High Mast Lighting Pole, Shroud
OPSD 2453.091	High Mast Lighting Pole, Shroud Details
OPSD 2453.140	High Mast Lighting Pole, Internal Drive Raising and Lowering Equipment - List of Components
OPSD 2453.150	High Mast Lighting Pole, Internal Drive Raising and Lowering Equipment - Layout
OPSD 2453.160	High Mast Lighting Pole, Internal Motor and Winch Details
OPSD 2453.170	High Mast Lighting Pole, Internal Drive Raising and Lower Equipment, 347/600V, 3-Phase, Wiring Diagram
OPSD 2453.180	High Mast Lighting Pole, Internal Drive Raising and Lower Equipment, 120/240V, 1-Phase Wiring Diagram
OPSD 2453.190	High Mast Lighting Pole, External Drive Raising and Lowering Equipment - List of Components
OPSD 2453.200	High Mast Lighting Pole, External Drive Raising and Lowering Equipment - Layout

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OPSD 2453.210	High Mast Lighting Pole, External Drive Raising and Lower Equipment, 347/600V, 3-Phase, Wiring Diagram
OPSD 2453.220	High Mast Lighting Pole, External Drive Raising and Lower Equipment, 120/240V, 1-Phase, Wiring Diagram

Note: The MUNI implemented in November 2019 replaces OPSS 631 COMMON, November 2015 with no technical content changes.

CONSTRUCTION SPECIFICATION FOR CONCRETE FOOTINGS AND MAINTENANCE PLATFORMS FOR HIGH MAST LIGHTING POLES

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631.09 **MEASUREMENT FOR PAYMENT**

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631-A **Commentary**

631.01 SCOPE

This specification covers the requirements for the installation of concrete footings and maintenance platforms for high mast lighting poles.

631.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

631.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

631.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 206	Grading
OPSS 501	Compacting
OPSS 603	Installation of Ducts
OPSS 609	Grounding
OPSS 903	Deep Foundations
OPSS 904	Concrete Structures
OPSS 905	Steel Reinforcement for Concrete
OPSS 906	Structural Steel for Bridges

Ontario Provincial Standard Specifications, Material

OPSS 1010	Aggregates - Base, Subbase, Select Subgrade, and Backfill Material
OPSS 1202	Bearings - Elastomeric Plain and Steel Laminated
OPSS 1350	Concrete - Materials and Production
OPSS 1440	Steel Reinforcement for Concrete
OPSS 1801	Corrugated Steel Pipe (CSP) Products
OPSS 2474	Anchorage Assembly - High Mast Lighting Pole

631.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Certificate of Conformance means a document issued by the Quality Verification Engineer confirming that the specified components of the Work are in general conformance with the requirements of the Contract Documents.

Earth means as defined in OPSS 206.

Quality Verification Engineer (QVE) means an Engineer retained by the Contractor qualified to provide the services specified in the Contract Documents.

631.05 MATERIALS

631.05.01 Concrete

Concrete shall be according to OPSS 1350 with a nominal minimum 28-Day compressive strength of 30 MPa.

631.05.02 Steel Reinforcement

Steel reinforcement shall be according to OPSS 1440.

631.05.03 Structural Steel

Structural steel shall be according to OPSS 906.

631.05.04 Corrugated Steel Pipe

Corrugated steel pipe shall be according to OPSS 1801 and as specified in the Contract Documents.

631.05.05 Neoprene Pad

Neoprene pad shall be according to the plain bearing requirements specified OPSS 1202.

631.05.06 Granular A

Granular A shall be according to OPSS 1010.

631.05.07 Sleeves and Ducts

Sleeves and ducts shall be according to OPSS 603.

631.05.08 Anchorage Assemblies

Anchorage assemblies shall be according to OPSS 2474.

631.07 CONSTRUCTION

631.07.01 General

General requirements for electrical work shall be as specified in the Contract Documents.

Concrete footings and maintenance platforms for high mast lighting poles shall be as specified in the Contract Documents.

631.07.02 Concrete Footings for High Mast Lighting Poles

631.07.02.01 Earth Excavation

Excavation of the pole base shall be to the neat lines and grades specified in the Contract Documents. When additional excavation beyond the neat limits is required, such excavation shall be a minimum of 300 mm beyond the neat dimensions of the footing to accommodate backfill.

The Contractor is responsible for constructing excavations without disturbing the sides or bases of the excavation.

When rock is encountered, the earth excavation shall be widened to the dimensions suitable for rock excavation or rock drilling operations. Rock excavation shall be according to OPSS 603.

631.07.02.02 Caisson Pile

Caisson piles shall be as specified in the Contract Documents and placed according to OPSS 903.

The base of the caisson or shallow foundation shall be cleaned of loosened or softened materials or both and inspected prior to pouring concrete. Complete documentation of the inspection and installation of each caisson shall be maintained and submitted to the Contract Administrator.

631.07.02.03 Steel Reinforcement

Steel reinforcement shall be placed according to OPSS 905.

631.07.02.04 Anchorage Assemblies

Anchorage assemblies of the size, diameter, length, and type specified in the Contract Documents shall be positioned in footings to obtain the proper position and handhole orientation.

Anchorage assemblies shall be securely tied to the steel reinforcement and provided with supports to maintain the position of the anchorage assembly during the placing of concrete. The anchorage assembly shall not be welded to the steel reinforcement.

The anchorage setting templates shall remain in place until immediately prior to the installation of the poles.

631.07.02.05 Sleeves and Ducts

Sleeves and ducts for footings shall be located to suit incoming duct or cable systems and shall be securely tied to the steel reinforcement and supported prior to the placing of concrete.

The number of sleeves shall be as specified in the Contract Documents.

Sleeves shall be cut off cleanly above the footing to a minimum of 150 mm above the pole base plate.

Sleeves shall be temporarily plugged or sealed until wiring is installed.

631.07.02.06 Concrete

Concrete shall be placed according to OPSS 904, except as noted herein.

In earth, concrete may be placed directly against the undisturbed earth or may be formed in place such that a minimum of 300 mm all around the footing is available for the placing of granular backfill. The upper portion of the footing shall be formed to a minimum of 150 mm below grade level. Formwork shall be removed to a minimum depth of 150 mm below finished grade prior to placing granular backfill.

In rock, concrete shall be placed directly against the excavated rock surfaces. Portions of footings in earth above the top of the rock surface shall be formed as noted in the previous paragraph.

Prior to the installation of the pole, the concrete shall have reached the minimum strength specified in the Contract Documents.

Concrete for the high mast lighting pole footings shall be cured according to OPSS 904, except as noted herein.

a) Wet burlap shall be applied to the top surface of the footing immediately after completion of the finishing operation without damaging or marring the surface of the concrete and shall be kept wet during the curing period.

b) When white pigmented membrane is used as a curing compound on adjacent concrete barrier wall, a minimum of one coat of the curing compound shall be applied to the concrete footing immediately after completion of the curing cycle for the footing. Additional curing compound shall be applied as necessary to ensure colour uniformity with the adjacent concrete barrier wall.

c) The curing compound shall only be used on the exposed final surfaces of the footing. Curing compound shall not be applied to construction joints.

631.07.02.07 Granular Backfill

Granular A backfill shall be placed around footings in earth and compacted according to OPSS 501.

631.07.02.08 Granular Apron

A granular apron consisting of Granular A shall be placed around each high mast lighting pole footing as specified in the Contract Documents.

631.07.02.09 Grading

Earth grading around the high mast lighting pole footings shall be as specified in the Contract Documents and OPSS 206.

631.07.03 Maintenance Platforms for High Mast Lighting Poles

631.07.03.01 Neoprene Pad

The size of the neoprene pad shall be as specified in the Contract Documents.

631.07.03.02 Fabrication, Delivery, and Installation

Fabrication, delivery, and installation of the platform and railing shall be according to OPSS 906 and the Contract Documents.

631.07.03.03 Grounding

Grounding shall be according to OPSS 609.

631.07.03.04 Mechanical Concrete Anchors

Mechanical concrete anchors shall be installed in accordance with the manufacturer's recommendations.

631.07.04 Quality Control

631.07.04.01 Submission of Certificate of Conformance

A Certificate of Conformance shall be submitted to the Contract Administrator upon completion of the work. The Quality Verification Engineer shall affix his or her seal and signature to the completed Certificate of Conformance confirming that the following are in general conformance with the requirements of the Contract Documents:

a) Work

b) Material and installations

c) Inspection, testing, and test results

The Certificate of Conformance shall include that:

a) The excavation was carried out without causing instability to the base and walls of the excavation.

b) The base of the caisson or shallow concrete foundation was cleaned of loosened or softened material or both prior to placing concrete.

c) The anchorage assemblies, sleeves, and ducts were properly placed in the centre of the concrete footings within a 15 mm tolerance.

d) The placement of concrete was completed according to OPSS 904.

631.07.05 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

631.09 MEASUREMENT FOR PAYMENT

631.09.01 Actual Measurement

631.09.01.01 Concrete Footings for High Mast Lighting Poles

For payment purposes, a count shall be made of the number of concrete footings for high mast lighting poles installed.

631.09.01.02 Maintenance Platform for High Mast Lighting Poles

For payment purposes, a count shall be made of the number of maintenance platforms for high mast lighting poles installed.

631.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clause under Actual Measurement.

631.10 BASIS OF PAYMENT

631.10.01 Concrete Footings for High Mast Lighting Poles - Item
Maintenance Platform for High Mast Lighting Poles - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

631.10.02 Rock Excavation for Electrical Installation

Payment for rock excavation for electrical installation shall be according to OPSS 603.

Appendix 631-A, November 2019
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Pole base excavation lines and grades. (631.07.02.01)

- Caisson pile requirements. (631.07.02.02)

- Anchorage assembly size, diameter, length, and type. (631.07.02.04)

- Number of sleeves into the pole bases. (631.07.02.05)

- Minimum concrete strength for pole installation. (631.07.02.06)

- Grading around pole footing requirements. (631.07.02.09)

- Maintenance platform requirements. (631.07.03)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 2210.030	High Mast Lighting Pole, Apron
OPSD 2218.010	High Mast Lighting Pole Anchorage Assembly Placement
OPSD 2456.010	High Mast Lighting Pole Anchorage Assembly Details for Double Base Plate
OPSD 2456.011	High Mast Lighting Pole Anchorage Assembly Details

CONSTRUCTION SPECIFICATION FOR PERMANENT SMALL SIGNS AND SUPPORT SYSTEMS

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703-A	Commentary

703.01 SCOPE

This specification covers the requirements for the installation and removal of permanent small signs and support systems, and the relocation of small signs.

703.01.01 Specification Significance and Use

This specification has been developed for use in municipal-oriented Contracts. The administration, testing, and payment policies, procedures, and practices reflected in this specification correspond to those used by many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

703.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

703.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 501 Compacting

Ontario Provincial Standard Specifications, Material

OPSS 2001 Signs

Ontario Ministry of Transportation Publications

Ontario Traffic Manual (OTM):
Book 1B - Sign Design Principles

CSA Standards

O80 Series-15	Wood Preservation
O141-05 (R2014)	Softwood Lumber

ASTM International

A 123/A 123M-17	Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
A 153/A153M-16	Zinc Coating (Hot-Dip) on Iron and Steel Hardware
A 780/A 780M-09 (2005)	Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings

Others

National Lumber Grade Authority (NLGA)
Canadian Wood Preservers Bureau (CWPB)

703.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Relocation means to move an existing permanent sign to a new chainage or offset or both.

Removal means to remove and dispose of an existing permanent sign or support system or both.

Sign and Sign Board means a traffic control device mounted on a fixed support that conveys a specific message by means of symbols and or words, and is officially erected for the purpose of regulating, warning, informing, and guiding traffic.

Sign Support System means a wooden or steel post of specified dimensions, hardware, and material embedded vertically into the ground for mounting signs at a specified height above the roadway and ground. The system may consist of a single, double, or triple post configuration.

Sign Hardware means hardware including, but not limited to, nuts, bolts, washers, spacers, and lock washers for attaching signs to sign support systems.

Small Sign Assembly means one or more signs mounted on a sign support system with specified sign hardware having a total sign or sign board area not greater than 3.6 m².

703.05 MATERIALS

703.05.01 General

The Contractor shall select a sign support system for each small sign assembly installation as specified in the Contract Documents.

All supplied components shall be according to the manufacturer's specifications and as specified in the Contract Documents. All sign hardware shall be hot dip galvanized according to ASTM A 153. New sign boards shall be supplied as specified in the Contract Documents.

703.05.02 Wooden Posts

703.05.02.01 General

All wooden posts shall be in dressed sizes and pressure treated with wood preservative.

The tolerance on the cross-sectional dimensions of all wooden posts shall be ± 2 mm.

703.05.02.02 Wood Preservative

Wood preservative shall be according to CAN/CSA O80 Series, Use Category UC 4.1.

703.05.02.03 Marking of Wood for Identification of Grade and Species

All wooden posts shall be stamped for species and grading according to CSA O141 by an approved agency authorized by the National Lumber Grade Authority (NLGA). The stamp shall be visible after installation and located at least 1.8 m from the bottom of the post.

703.05.02.04 Marking of Wood for Identification of Preservative Treatment

All wooden posts shall be stamped for wood preservative treatment using a certification mark authorized by the Canadian Wood Preservers Bureau (CWPB). The wood preservative stamp shall be visible after installation and located at least 1.8 m from the bottom of the post.

703.05.03 Metal Posts

703.05.03.01 General

All supplied metal posts, bolts, washers, and nuts shall be according to the manufacturer's specifications and the Contract Documents.

All metal posts shall be hot dip galvanized after fabrication according to ASTM A 123.

All sign hardware shall be hot dip galvanized according to ASTM A 153.

703.05.04 Signs

Signs shall be according to OPSS 2001.

703.07 CONSTRUCTION

703.07.01 General

All breakaway and non-breakaway sign support systems shall be installed according to the manufacturer's specifications and as specified in the Contract Documents at locations specified in the Contract Documents.

All sign boards shall be installed according to OTM Book 1B and as specified in the Contract Documents.

All signs shall be installed, relocated, or removed at locations specified in the Contract Documents. Signs shall be installed so that they do not obstruct and are not obstructed by existing permanent signs or other objects. The Contract Administrator shall be notified prior to installation of sign supports if it is not possible to install a new or relocated sign as specified in the Contract Documents due to this requirement.

Signs shall be covered temporarily for traffic operational reasons when directed by the Contract Administrator. Signs shall be covered so they are not visible to approaching motorists. The cover shall remain securely in place until the signs are appropriate for display as directed by the Contract Administrator. The covering material shall not damage or make any marks on the signs.

Acceptable material from post hole excavation shall be used as backfill around posts and compacted according to OPSS 501.

Posts shall be plumb within a tolerance of ± 20 mm. The sign shall be levelled on a multiple post system within a tolerance of ± 10 mm.

Back-to-back signs may be installed on single or multiple posts. The sign support system shall be selected based on the largest sign area on one side of the post.

Cut ends and field drilled holes shall receive two applications of 2% copper napthenate wood preservative. Field applied wood preservative that comes in contact with any metal components shall be removed immediately.

Damaged and cut areas of hot dip galvanized coatings on any galvanized components shall be repaired according to ASTM A 780.

703.07.02 Sign Supply

Signs shall be supplied by the Owner or by the Contractor as specified in the Contract Documents.

703.07.02.01 Owner Supplied Signs

703.07.02.01.01 Sign Ordering

The Contractor shall submit a list of signs required for this Contract to the Contract Administrator. The list of signs shall contain the quantity and details of the signs and the date for pick up by the Contractor. The list of signs shall be submitted a minimum of 12 weeks prior to the pickup date.

703.07.02.01.02 Sign Pickup

The Contractor shall pickup all the ordered signs on the list of required signs at a location provided in the Contract Documents to be supplied by the Owner within 10 Business Days of receiving notice from the Contract Administrator that the signs are ready for pickup. The Contractor shall ensure that all signs are safely secured and packaged prior to transporting the signs.

703.07.02.01.03 Sign Confirmation and Inspection

The Contractor shall within 5 Business Days confirm in writing with the Contract Administrator that all the ordered signs were received in accordance with the list of required signs. The Owner shall be notified of any incorrect signs identified by the Contractor. The Contractor shall be responsible for the cost of replacing all damaged, missing, and incorrect signs subsequent to the Contractor's order confirmation.

703.07.02.02 Contractor Supplied Signs

The Contractor shall supply all signs as specified in the Contract Documents.

703.07.03 New Signs

New sign boards shall be attached to new sign support systems with sign hardware as specified in the Contract Documents.

703.07.04 Relocation of Signs

Relocated sign boards shall be attached to new support systems with sign hardware as specified in the Contract Documents. No portion of the existing sign, support system, and sign hardware shall be left at the original sign location and any excess material including support system and sign hardware shall be managed as specified in the Contract Documents or as directed by the Contract Administrator.

703.07.05 Removal of Signs

No portion of the removed sign, support system, and sign hardware shall be left at the original sign location and any excess materials shall be managed as specified in the Contract Documents.

703.07.06 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

703.09 MEASUREMENT FOR PAYMENT

703.09.01 Actual Measurement

703.09.01.01 Small Signs, Ground Mounted, New

For measurement purposes, a count shall be made of the number of new small sign assemblies installed.

703.09.01.02 Small Signs, Relocation

For measurement purposes, a count shall be made of the number of small sign assemblies relocated.

703.09.01.03 Small Signs, Removal

For measurement purposes, a count shall be made of the number of small sign assemblies removed.

703.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clause under Actual Measurement.

703.10 BASIS OF PAYMENT

703.10.01 Small Signs, Ground Mounted, New - Item
Small Signs, Relocation - Item
Small Signs, Removal - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Costs associated with any required repairs or removals and replacements of defective materials shall be the Contractor's responsibility at no additional cost to the Owner.

Appendix 703-A, April 2019
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- New sign board material requirements. (703.05.01)

- Locations of breakaway and non-breakaway sign support systems. (703.07.01)

- Locations of signs to be installed, relocated, or removed. (703.07.01)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 985.110 to 990.110 Small Sign Support Systems

CONSTRUCTION SPECIFICATION FOR POST MOUNTED DELINEATORS

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704.04 **DESIGN AND SUBMISSION REQUIREMENTS - Not Used**

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704.09 **MEASUREMENT FOR PAYMENT**

704.10 **BASIS OF PAYMENT**

APPENDICES

704-A **Commentary**

704.01 SCOPE

This specification covers the requirements for the installation of post mounted delineators.

704.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

704.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

704.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Material

OPSS 2001 Signs

Ontario Ministry of Transportation Publications

Ontario Traffic Manual (OTM):
Book 11 - Pavement, Hazard and Delineation Markings

ASTM International

A36/A36M-19	Carbon Structural Steel
A123/A123M-17	Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
A153/A153M-16a	Zinc Coating (Hot-Dip) on Iron and Steel Hardware
D4956-19	Retroreflective Sheeting for Traffic Control

704.05 MATERIALS

704.05.01 Delineator Posts

Delineator post dimensions shall be as specified in the Contract Documents.

Delineator posts shall be fabricated from steel according to ASTM A36M and hot dip galvanized after fabrication according to ASTM A123M.

704.05.02 Hardware

Hardware shall be as specified in the Contract Documents. All hardware shall be hot dip galvanized according to ASTM A153M.

704.05.03 Delineators

Delineators shall be outfitted with high intensity retroreflective sheeting according to ASTM D4956, Type III or IV; and the colour according to OTM Book 11. Dimensions shall be as specified in the Contract Documents. Sign blanks shall be metal and according to OPSS 2001 with dimensions as specified in the Contract Documents.

704.07 CONSTRUCTION

704.07.01 General

Post mounted delineators shall be installed plumb and set according to alignment and grade according to and at the locations and spacing specified in the Contract Documents.

704.07.02 Delineators

Delineators shall be mounted on the posts as specified in the Contract Documents. Delineators shall be centred vertically and horizontally over the post holes. The type shall be as specified in the Contract Documents.

704.07.03 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

704.09 MEASUREMENT FOR PAYMENT

704.09.01 Actual Measurement

704.09.01.01 Post Mounted Delineators

For measurement purposes, a count shall be made of the number of complete post mounted delineators installed.

704.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

704.10 BASIS OF PAYMENT

704.10.01 Post Mounted Delineators - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

Costs associated with any required removals and replacement or repairs of defective work and materials shall be the Contractor’s responsibility at no additional cost to the Owner.

Appendix 704-A, April 2021
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Post mounted delineator locations and spacing. (704.07.01)

- Type A or Type B post mounted delineators. (704.07.02)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 984.101 Post Mounted Delineator, Installation

CONSTRUCTION SPECIFICATION FOR FLEXIBLE DELINEATOR POSTS

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705.09 **MEASUREMENT FOR PAYMENT**

705.10 **BASIS OF PAYMENT**

APPENDICES

705-A **Commentary**

705.01 SCOPE

This specification covers the requirements for the installation of permanent and temporary flexible delineator posts and relocation of temporary flexible delineator posts.

705.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

705.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

705.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standards Specifications, Material

OPSS 1212 Hot Poured Rubberized Asphalt Joint Sealing Compound

Ontario Ministry of Transportation Publications

Designated Sources for Material (DSM)

Ontario Traffic Manual (OTM):
Book 7 - Temporary Conditions
Book 11 - Pavement, Hazard and Delineation Markings

ASTM International

D4956-19 Retroreflective Sheeting for Traffic Control

705.03 DEFINITIONS

For the purpose of this specification, the following definition applies:

Flexible Delineator Post means a tubular plastic marker installed vertically for the purpose of channelizing traffic or delineating roadside features in temporary or permanent applications. The tubular post is securely fixed to the ground surface by hinged (flexible) connection to a solid base. When impacted by a vehicle, the post has the ability to bend 90° from vertical and self-restore following impacts.

705.04 DESIGN AND SUBMISSION REQUIREMENTS

705.04.01 Submission Requirements

One copy of the manufacturer's installation instructions shall be submitted to the Contract Administrator.

Installation of the flexible delineator posts shall not commence until the Contract Administrator has received the copy of the instructions.

705.05 MATERIALS

705.05.01 Flexible Delineator Posts

Flexible delineator posts shall be supplied from a source named on the ministry's DSM.

All supplied system components shall be according to the manufacturer's specifications.

The height of the post shall be as specified in the Contract Documents.

The post colour shall match the colour of the reflective sheeting.

To maintain a visually consistent installation, only one product shall be used on the Contract.

705.05.02 Anchor and Support Hardware

Anchor and support hardware used to fix the flexible delineator post to the ground surface shall be supplied by the manufacturer.

705.05.03 Reflective Sheeting

Flexible delineator posts shall be outfitted with high intensity retroreflective sheeting according to ASTM D4956, Type III or IV. For permanent conditions, the colour shall be according to OTM Book 11. For temporary conditions, the colour shall be according to OTM Book 7. Dimensions, spacing, and quantity shall be as specified in the Contract Documents.

705.05.04 Temporary Flexible Delineator Posts

Temporary flexible delineator posts may be reused provided each post meets each of the following criteria:

a) The ability to bend 90° from vertical and self-restore to a vertical position after impacts.

b) The base is intact and permits anchorage to the ground surface that is equivalent to a new post.

c) The post is intact without any cracks or fissures.

d) The retroreflective sheeting is fully intact with only minor tears or scratches that do not affect the reflectivity of the sheeting.

705.07 CONSTRUCTION

705.07.01 General

Permanent and temporary flexible delineator posts shall be installed and securely fixed to the ground surface according to the manufacturer's instructions at locations specified in the Contract Documents.

705.07.02 Relocation of Temporary Flexible Delineator Posts

Flexible delineator posts shall be relocated as specified in the Contract Documents, including the removal of existing and installation of new anchorage hardware and adhesives.

All holes resulting from the relocation of the delineator post assemblies shall be filled with a hot poured rubberized asphalt joint sealing compound according to OPSS 1212 when they are located in areas not to be resurfaced as part of the Work. At the time of filling, the holes shall be dry and free of dust and debris.

705.07.03 Maintenance of Temporary Flexible Delineator Posts

Flexible delineator posts shall be maintained for the duration of the construction period for which they are required.

Flexible delineator posts shall be monitored on a daily basis. Missing or broken flexible delineator posts shall be replaced within 48 hours.

Posts that do not have a uniform or satisfactory appearance to the satisfaction of the Contract Administrator shall be replaced or corrected within 48 hours of notification.

705.07.04 Removal of Temporary Flexible Delineator Posts

Flexible delineator posts and associated hardware and adhesives shall be removed at the completion of the construction period for which they were required.

All holes resulting from the removal of the delineator post assemblies shall be filled with a hot poured rubberized asphalt joint sealing compound according to OPSS 1212 when they are located in areas not to be resurfaced as part of the Work. At the time of filling, the holes shall be dry and free of dust and debris.

705.07.05 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

705.09 MEASUREMENT FOR PAYMENT

705.09.01 Actual Measurement

705.09.01.01 Flexible Delineator Post - Permanent

For measurement purposes, a count shall be made of the number of complete flexible delineator posts installed.

705.09.01.02 Flexible Delineator Post - Temporary

For measurement purposes, a count shall be made of the number of complete flexible delineator posts installed and removed, up to the maximum number of flexible delineator posts required to be in place at any one time during the Contract.

705.09.01.03 Flexible Delineator Post - Relocation

For measurement purposes, a count shall be made of the number of complete flexible delineator posts relocated. Flexible delineator posts that are temporarily surplus and are required for future stages shall be paid for as one relocation for the combined moves into and out of storage, including any off-site storage required due to on-site restrictions.

705.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

705.10 BASIS OF PAYMENT

705.10.01 Flexible Delineator Post - Permanent - Item
Flexible Delineator Post - Temporary - Item
Flexible Delineator Post - Relocation - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

When the Contract contains separate items for the work required by this specification, payment shall be at the Contract price and according to the specification for such work.

Costs associated with any required removals and replacement or repairs of defective work and materials shall be the Contractor's responsibility at no additional cost to the Owner.

Appendix 705-A, April 2021
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- A list of approved manufacturers. (705.05.01)

- Post height. (705.05.01)

- Dimensions, spacing, and quantity of retroreflective sheeting. (705.05.03)

- Flexible delineator post locations. (705.07.01)

- Relocation of flexible delineator posts. (705.07.02)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 984.105 Flexible Delineator Post, Installation – Temporary and Permanent

CONSTRUCTION SPECIFICATION FOR TEMPORARY TRAFFIC CONTROL DEVICES

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APPENDICES

706-A **Commentary**

706.01 SCOPE

This specification covers the requirements for the use of temporary traffic control devices during construction.

706.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

706.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

706.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 703 Permanent Small Signs and Support Systems

Ontario Provincial Standard Specifications, Material

OPSS 2001 Signs

Ontario Ministry of Transportation Publications

Ontario Traffic Manual (OTM):
Book 7 – Temporary Conditions

Designated Sources for Materials (DSM)

706.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Temporary Traffic Control Signs means all traffic control signs and associated devices identified in OTM Book 7, including vehicles and sign trailers required to support signs and equipment to supply sign lighting; but excludes highway number markers.

Small Sign means as defined in OPSS 703.

706.04 DESIGN AND SUBMISSION REQUIREMENTS

706.04.01 Submission Requirements

A copy of the traffic control plan shall be submitted to the Contract Administrator at the pre-construction meeting.

706.05 MATERIALS

706.05.01 Retroreflective Sheeting

Retroreflective sheeting shall be according to OPSS 2001.

706.05.02 Automated Flagger Assistance Devices

Automated flagger assistance devices (AFAD) shall be according to OTM Book 7.

706.05.03 Temporary Traffic Control Signs

Temporary traffic control signs shall be according to OTM Book 7.

706.05.04 Portable Variable Message Signs

Portable variable message signs (PVMS) shall be supplied from a source named on the MTO DSM.

706.05.04.01 Modem

Modem requirements for PVMS shall be as specified in the Contract Documents.

706.07 CONSTRUCTION

706.07.01 Temporary Traffic Control Signs

706.07.01.01 General

The work of temporary traffic control signs shall include:

a) Installation and relocation according to OTM Book 7.

b) Temporarily relocating, modifying as required, and reinstalling existing small signs.

c) Installing and removing contract information signs.

d) Installing and removing Speed Fines Doubled (TC-90) signs.

Messaging for all temporary traffic control signs shall be according to OTM Book 7.

When a Contract is in a designated bilingual area, bilingual temporary traffic control signs shall be installed. If a bilingual temporary traffic control sign is not available, then the French temporary traffic control sign shall be installed. A French Construction Zone Begins sign (Rb-90AF) and a French Construction Zone Ends sign (Rb-90BF) shall be installed next to the corresponding English Rb-90A and Rb-90B signs. All other French temporary traffic control signs shall be installed 150 m downstream from the English sign.

Temporary traffic control signs shall be installed before work affecting traffic begins, remain operational throughout the duration of the operation requiring signs and be removed upon completion of the operation.

Prior to seasonal shutdown, temporary traffic control signs shall be reviewed and signs that are not required during the seasonal shutdown period shall be removed. At the end of the seasonal shutdown period, the removed signs shall be reinstalled as required.

The condition of the temporary traffic control signs shall meet the quality replacement guidelines specified in OTM Book 7 for the duration of the Work. Signs that do not meet the guidelines shall be removed and replaced.

706.07.01.02 Existing Small Signs

Any existing small signs, excluding Tourism-Oriented Directional Signing and Logo Sign Program signs, removed to accommodate construction shall be kept operational by placement on a temporary support. Temporarily relocated existing small signs shall be kept at the same height, offset, and approximate location from traffic as before relocation. All existing small signs shall be reinstalled, at or as close as possible to the original location, according to OPSS 703 upon completion of the Work.

Temporary modifications to existing small signs shall be according to OTM Book 7.

706.07.01.03 Contract Information Signs

Contract information signs shall be installed according to OTM Book 7 and removed upon completion of the Work. Contract information signs shall be either a TC-81 sign or an Owner supplied contract information sign.

Owner supplied contract information signs shall be picked up at the location specified in the Contract Documents. The Contractor shall arrange for the pickup of the signs. At Contract completion, Owner supplied contract information signs shall be returned to the Owner at a location specified by the Contract Administrator.

706.07.02 Road Closing/Restriction Notice Sign (TC-64)

Road closing/restriction notice (TC-64) signs shall be installed and relocated at locations specified in the Contract Documents. Timing requirements for TC-64 signs shall be as specified in OTM Book 7.

The Contract Administrator shall be notified when the Contractor's operations results in changes to the TC-64 sign message details (i.e., dates, times, etc.).

706.07.03 Automated Flagger Assistance Devices

AFAD shall be installed, relocated, and removed at locations as specified in the Contract Documents.

If the closure extends across an entrance or side road, a traffic control person shall also be present to direct traffic with a stop/slow paddle according to OTM Book 7.

706.07.04 Portable Variable Message Sign

Installation, including the construction of a temporary base; relocation; and messaging on the PVMS shall be as specified in the Contract Documents. The exact location of the PVMS shall be proposed by the Contractor and shall meet the following criteria:

a) Maximizes visibility for motorists without impacting safety in accordance with the Owner's clear zone requirements.

b) Installed on a level surface with adequate bearing capacity to support the weight of the PVMS and temporary base materials.

The Contract Administrator shall approve the location of the PVMS prior to it being deployed. The Contractor Administrator shall be notified at least 2 Business Days in advance regarding the delivery, relocation, and removal of PVMS within the construction work zone.

Modem installation, testing, and decommissioning for the PVMS shall be as specified in the Contract Documents.

The PVMS control box shall be secured from entry by unauthorized personnel. There shall be security measures or devices in place to prevent message tampering of the sign.

All PVMS and any temporary base shall be removed upon completion of the Work.

706.07.04.01 Maintenance of Portable Variable Message Sign

Maintenance shall be performed for the continuous operation of the PVMS, as required, throughout the duration of the Contract. Daily inspection of the PVMS shall be conducted to ensure that the PVMS meets the following maintenance requirements:

a) PVMS sign face is aimed with the sign sight tube to the centre of the approach roadway approximately 200 m upstream of the sign to ensure maximum visibility.

b) Solar panels are tilted and rotated to face south.

c) All pixels and LEDs in the sign face remain operational.

d) Sign is elevated to its maximum height with the locking pin in place; sign face is to be regularly cleaned from dirt, road salt, or debris that may obstruct the visibility of the sign.

e) Batteries are replaced as needed to ensure that battery levels are maintained per the supplier's operational requirements.

f) Modems and other remote communications equipment remain operational.

Immediate repairs shall be required whenever there is a failure or cessation of the operation of any components of the PVMS. The Contract Administrator shall be notified immediately each time repair work is performed on a PVMS.

706.07.05 Seasonal Shutdown

During seasonal shutdown, the Owner shall take responsibility for the maintenance, including replacement, of construction signs unless otherwise specified.

Responsibility for the maintenance of construction signs during seasonal shutdown shall not be assumed by the Owner until the signing has been inspected, sign installation deviations from OTM Book 7 corrected and signing approved in writing by the Owner.

Construction signs placed, replaced or repaired by the Owner during seasonal shutdown shall become the property of the Contractor.

Upon resumption of operations, the Contractor shall review and provide written acceptance of the signing; deviations from OTM Book 7 shall be noted and these shall be corrected by the Owner. Once deviations are repaired, the Contractor shall resume responsibility as specified herein.

706.07.06 Management of Excess Materials

Management of excess materials shall be according to the Contract Documents.

706.09 MEASUREMENT FOR PAYMENT

706.09.01 Actual Measurement

706.09.01.01 Automated Flagger Assistance Devices

For measurement purposes, a count shall be made of the number of AFAD installed.

706.09.01.02 Automated Flagger Assistance Devices, Relocation

For measurement purposes, a count shall be made of the number of AFAD relocated.

AFAD that are temporarily surplus for intermediate stages, but will be required later shall be paid as one relocation for the combined moves into and out of the site storage, including any off-site storage required due to space restrictions.

706.09.01.03 Portable Variable Message Sign (Temporary)

For measurement purposes, a count shall be made of the number of PVMS installed.

706.09.01.04 Portable Variable Message Sign, Relocation

For measurement purposes, a count shall be made of the number of PVMS relocated.

PVMS that are temporarily surplus for intermediate stages, but will be required later shall be paid as one relocation for the combined moves into and out of the site storage, including any off-site storage required due to space restrictions.

706.09.01.05 Road Closing/Restriction Notice Signs (TC-64)

For measurement purposes, a count shall be made of the number of TC-64 signs installed.

706.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clause under Actual Measurement.

706.10 BASIS OF PAYMENT

706.10.01 Automated Flagger Assistance Devices - Item
Automated Flagger Assistance Devices, Relocation - Item
Portable Variable Message Sign (Temporary) - Item
Portable Variable Message Sign, Relocation - Item

Payment at the Contract price for the above items shall be full compensation for all labour, Equipment, and Material to do the work.

706.10.02 Temporary Traffic Control Signs - Item

Payment at the Contract price for the above item shall be full compensation for all labour, Equipment, and Material to do the work.

For progress payment, 50% of the Contract price shall be paid upon the supply and installation of the complete initial traffic control plan. The balance will be prorated over the balance of the Contract Time.

Reinstallation of temporary traffic control signs after seasonal shutdown shall be at no additional cost to the Owner.

706.10.03 Road Closing/Restriction Notice Signs (TC-64) - Item

Payment at the Contract price for the above item shall be full compensation for all labour, Equipment, and Material to do the work.

Changes to the TC-64 sign message details (i.e., dates, times, etc.) required as a result of the Contractor's operations shall be completed at no additional cost to the Owner.

Progress payments shall be made as follows:	60% of the unit price per sign upon installation; 20% of the unit price per sign upon relocation; 20% of the unit price per sign upon removal.
If no relocation is required:	60% of the unit price per sign upon installation; 40% of the unit price per sign upon removal.

706.10.04 Removals and Replacements

The removal and replacement of defective workmanship or materials shall be at no additional cost to the Owner.

Appendix 706-A, April 2018
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Modem requirements for PVMS. (706.05.04.01)

- The location of Owner supplied contract information signs to be picked up and returned. (706.07.01.03)

- Locations and relocations of road closing/restriction notice (TC-64) signs. (706.07.02)

- Locations, relocations, and removal locations of AFAD. (706.07.03)

- Requirements for the installation, including the construction of a temporary base; relocation; and messaging on the PVMS. (706.07.04)

- Requirements for modem installation, testing, and decommissioning for the PVMS. (706.07.04)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

CONSTRUCTION SPECIFICATION FOR MODIFIED OVERHEAD SIGNBOARDS

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707.08 **QUALITY ASSURANCE – Not Used**

707.09 **MEASUREMENT FOR PAYMENT**

707.10 **BASIS OF PAYMENT**

APPENDICES

707-A **Commentary**

707.01 SCOPE

This specification covers the requirements for the installation of new overlay signboards on existing overhead extruded signboards.

707.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

707.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

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Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

707.07 CONSTRUCTION

707.07.01 General

All existing overlay signboard panels shall be removed by drilling out all pop rivets used to fasten it to the extruded sign.

New overlay signboard panels shall be installed according to the sign details.

Aluminum pop rivets, 3 x 11 mm (1/8" x 7/16"), shall be used to install the overlay panel directly on top of the existing extruded sign. Rivets shall be spaced around the perimeter of each overlay panel 25 mm (1") from the edge of the panel at 150 mm (6") centre to centre spacing.

Inside each 1220 mm (4') panel, 6 aluminum pop rivets shall be inserted equally spaced 610 mm (24") from the edge of the panel. Inside each 914 mm (3') panel, 6 aluminum pop rivets shall be inserted equally spaced 450 mm (18") from the edge of the panel. If the panel is over 1830 mm (6') in height, 6 pop rivets shall be installed equally spaced 450 mm (18") from the edge of the panel.

To ensure panels do not peel, 6 mm (1/4") stainless steel self-tapping screws shall be attached to the corners of all overlay panels, regardless of size.

707.07.02 Sign Ordering

The following shall be submitted to the Contract Administrator a minimum of 12 weeks prior to the installation date:

a) List of all required overlay signboards.

b) Sign details for the overlay signboards.

c) Date for pick-up.

707.07.03 Sign Pick up

All ordered signboards shall be picked up at the location specified in the "Schedule of Materials to be Supplied by the Owner" within 10 Business Days of receiving notice from the Contract Administrator that the signs are ready for pick up.

707.07.04 Management of Excess Material

Management of excess material shall be as specified in the Contract Documents.

707.09 MEASUREMENT FOR PAYMENT

707.09.01 Actual Measurement

707.09.01.01 Modified Overhead Signboards

For measurement purposes, a count shall be made of each modified signboard installed.

707.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

707.10 BASIS OF PAYMENT

707.10.01 Modified Overhead Signboards - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

Appendix 707, November 2021
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Location of signboards to be picked up. (707.07.03)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

CONSTRUCTION SPECIFICATION FOR PORTABLE TEMPORARY TRAFFIC SIGNALS

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708.07 **CONSTRUCTION**

708.08 **QUALITY ASSURANCE – Not Used**

708.09 **MEASUREMENT FOR PAYMENT**

708.10 **BASIS OF PAYMENT**

APPENDICES

708-A **Commentary**

708.01 SCOPE

This specification covers the requirements for the installation, operation, and maintenance of portable temporary traffic signals.

708.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

708.01.02 Appendices Significance and Use

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708.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Ministry of Transportation Publications

Designated Sources for Materials (DSM)

Ontario Traffic Manual (OTM):
Book 7 - Temporary Conditions
Book 12 - Traffic Signals

Institute of Transportation Engineers

ST-017B Equipment and Material Standards of the Institute of Transportation Engineers, April 3, 2006

708.03 DEFINITIONS

For the purpose of this specification, the following definition apply:

Portable Temporary Traffic Signals (PTTS) means two traffic control signal heads mounted onto a movable trailer.

708.05 MATERIALS

708.05.01 Portable Temporary Traffic Signals

Portable temporary traffic signals shall be supplied from a source named on the MTO's DSM.

Traffic control signal heads shall have a minimum clearance height of 5 m from bottom of signals to finished grade for both the primary and secondary signal heads.

Primary and secondary signal heads shall be separated by a minimum of 3 m measured laterally.

Signal heads shall be reversible on the trailer's boom.

Highway yellow backboards shall be used on each signal head.

Lenses shall be convex prismatic of the polycarbonate or glass type according to chromaticity characteristics specified in ITE ST-017B and with the size, type, colour, and orientation specified in the Contract Documents.

708.05.02 Temporary Illumination

Temporary illumination shall be provided for all PTTS installations being used at night. Temporary illumination shall meet the following requirements:

a) A minimum of one luminaire shall be mounted over each PTTS trailer.

b) Each luminaire shall have a minimum light output of 22,000 lumens.

c) Each luminaire shall be mounted a minimum of 9 m vertically above the roadway surface.

d) The temporary illumination shall be powered by generator or line power.

e) Temporary illumination shall be on from dusk until dawn. If the temporary illumination has a photo controller, then the temporary illumination shall be switched on when ambient light levels are at 16 Lux and lower and switched off when ambient light levels are at 50 Lux and higher.

708.07 CONSTRUCTION

708.07.01 General

PTTS and its temporary illumination shall be installed and relocated at the locations specified in the Contract Documents or on the signed legal drawing (PHM-125). PTTS shall be installed on a level and stable surface that allows for on-site maintenance and service of the units.

PTTS shall be positioned to prevent displacement or damage by weather, maintenance activities, vehicle impact, or vandalism.

The Contract Administrator shall be given a minimum of 24-hour notice prior to the activation of the PTTS. PTTS shall be activated in the presence of the Contract Administrator.

708.07.02 Operational Constraints

Operation of PTTS shall be permitted between April 1st and November 30th of each calendar year. The operation of PTTS outside of this period shall not be permitted unless otherwise approved by the Contract Administrator. If PTTS are permitted outside of this period, the PTTS shall be configured with environmental controls to permit operation at any temperature.

When not in use, the PTTS shall be removed or the traffic control signal heads covered or turned up and/or away from the roadway.

708.07.03 Operational Capabilities

708.07.03.01 Portable Traffic Control Signals

The installation and operation of portable temporary traffic signals shall be according to the OTM Book 7 and the traffic control signal head display criteria specified in OTM Book 12.

PTTS shall have the following operational capabilities:

a) Pre-timed signal operations such that the green time, the amber clearance, and the all red times are manually inputted into the controller.

b) Fully actuated operation using a variety of detection devices including loops, microwave, video, or non-loop in-pavement detection equipment that will:

   i) Place a call for a green indication when red or amber is being displayed.
   ii) Extend the green indication from a minimum to a maximum green time by a user selectable amount each time a vehicle is detected during the green display (extension time).

c) Rest in red or the last phase served. The user must be able to select this mode through software input on a construction site.

d) The user must be able to manually enter a minimum green time, a maximum green time, and an extension time for actuated operations.

e) All timing intervals are capable of being set in increments of one second.

f) Default mode – flashing red shall display in both directions (at both master and local trailers) at the same time.

g) Manual mode – shall allow an operator to interrupt the other modes and return to the previous mode when finished.

h) Default mode warning system – PTTS shall have the email, text messaging, or cell/satellite paging warning system activated and monitored, to advise the Owner/operator and/or Contractor when the signals have gone into the “default mode”.

i) Be able to communicate between the master and local units through either radio or hardwire with conflict monitoring enabled to ensure malfunctions are identified. The units shall be set up so that if communications are lost, both units will revert to “default mode” operation.

j) All conflicts must be recorded in an error log with the exact date and time of the occurrence. The error log must be retrievable by the Owner.

708.07.03.02 Trailer Unit

Each PTTS trailer unit shall have the following operational capabilities:

a) Be able to operate as either a master or local.

b) Be interconnected by either hardwire or radio.

708.07.03.03 Controller

Each controller shall have the following operational capabilities:

a) Be capable of providing variable all red clearance intervals between 0 – 600 seconds.

b) Have circuitry that detects low voltage and prevents the occurrence of an unsafe (conflicting) signal indication. In the event of low voltage, the signal must default to a flashing all red.

c) Must be password protected or have other security devices in place to prevent program tampering.

d) Provide a red flash cycle that is flashed continuously at a rate of 50 – 60 times per minute with a 50% duty cycle.

e) If a radio interconnection is used then the system must have a mobile license from Industry Canada.

708.07.03.04 Power Supply

The PTTS shall be powered by one or more of the following methods:

a) Generator.

b) Solar power.

c) Electrical line power.

If a generator is being used to power the PTTS and temporary illumination, suitable housing and sound reduction measures shall be installed to enclose the generator and reduce external noise levels to less than 45 dBA measured at a distance of 7 m from the generator. The housing shall provide sufficient ventilation to prevent overheating and permit exhausting of any hazardous fumes.

The PTTS shall have a battery backup with a battery capacity sufficient to operate the system for a minimum of 14 days without recharging.

The power supply and other electronic controls shall be completely inaccessible to unauthorized personnel and protected by a sturdy, lockable, metal enclosure.

708.07.04 Traffic Signal Control Programming and Timing

A technical expert knowledgeable in the operation of the PTTS shall be at the site to provide assistance during the initial set-up of the unit and shall remain on site until the unit is operating to the satisfaction of the Contract Administrator.

The traffic signal timing as specified in the Contract Documents shall be programmed into the traffic signal controller.

The controller shall be set up by performing all programming, setting all timing controls, switch settings, and conflict monitoring.

708.07.05 Temporary Traffic Signals Supplied by Owner

When the Owner supplies the PTTS, the PTTS shall be picked up and transported from the Owner's premises as specified in the Contract Documents. Once the PTTS is placed into operation, the operation, and maintenance of the PTTS shall be completed at no additional cost to the Owner.

PTTS shall be returned to the Owner's premises or to an alternate site specified by the Contract Administrator within 7 Days of being taken out of operation.

708.07.06 Maintenance of Portable Temporary Traffic Signals

Routine, non-routine, and emergency maintenance work required for continuous and proper operation of the PTTS shall be performed as specified in the Contract Documents.

A technical expert shall be available on-call 24 hours a day, 7 days a week, to troubleshoot any PTTS problems on site and perform all work required to restore the PTTS to full operation.

When directed by the Contract Administrator, the traffic signal operation shall be manually overridden to reduce or eliminate queuing traffic.

A logbook shall be maintained and kept with the PTTS or at a location agreed upon with the Owner. The logbook shall record any fieldwork performed on the PTTS system, including the replacement of any hardware, changes to the software, or changes to the configuration, phasing, or timing parameters. The time and date of each entry in the logbook shall be signed by the individual making the entry.

708.09 MEASUREMENT FOR PAYMENT

708.09.01 Portable Temporary Traffic Signals

For measurement purposes, a count shall be made of the number of PTTS installed. Each PTTS shall be counted only once, regardless of the number of times it is relocated.

708.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clause under Actual Measurement.

708.10 BASIS OF PAYMENT

708.10.01 Portable Temporary Traffic Signals - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work, including all relocations of the PTTS.

Site visits by the technical expert required to restore the PTTS to full operation shall be at no additional cost to the Owner.

Appendix 708-A, April 2018
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Size, type, colour, and orientation of lenses. (708.05.01)

- Locations and relocations of PTTS and its temporary illumination. (708.07.01)

- Traffic signal timing requirements to be programmed into the traffic signal controller. (708.07.04)

- When the Owner supplies the PTTS, the location of the PTTS to be picked up. (708.07.05)

- Routine, non-routine, and emergency maintenance work requirements for continuous and proper operation of the PTTS. (708.07.06)

Related Ontario Provincial Standard Drawings

No information provided here.

CONSTRUCTION SPECIFICATION FOR PERMANENT INTERMEDIATE SIGNS AND SUPPORT SYSTEMS

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APPENDICES

709-A **Commentary**

709.01 SCOPE

This specification covers the requirements for the installation and removal of permanent intermediate signs and support systems, and the relocation of intermediate signs.

709.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

709.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

709.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 501 Compacting

Ontario Provincial Standard Specifications, Material

OPSS 2001 Signs

Ontario Ministry of Transportation Publications

Ontario Traffic Manual (OTM):
Book 1B - Sign Design Principles

ASTM International

A 123/A 123M-17	Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
A 153/A 153M-16	Zinc Coating (Hot-Dip) on Iron and Steel Hardware
A 780/A 780M-09 (2015)	Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings

709.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Intermediate Sign Assembly means one or more plywood sign boards with a total area not greater than 7.2 m² mounted on a metal post breakaway sign support system with specified sign hardware.

Relocation means to move an existing permanent sign to a new chainage or offset or both.

Removal means to remove and dispose of an existing permanent sign or support system or both.

Sign Board means a traffic control device mounted on a fixed support that conveys a specific message by means of symbols and or words, and is officially installed for the purpose of regulating, warning, informing, and guiding traffic.

Sign Hardware means hardware including, but not limited to, nuts, bolts, washers, spacers, and lock washers for attaching sign boards to sign support systems.

Sign Support System means a steel post of specified dimensions, hardware, and material embedded vertically into the ground for mounting sign boards at a specified height above the roadway and ground. The system may consist of a single, double, or triple post configuration.

709.05 MATERIALS

709.05.01 General

A sign support system shall be used for each intermediate sign assembly installation as specified in the Contract Documents.

New sign boards shall be supplied as specified in the Contract Documents.

709.05.02 Metal Posts and Components

All supplied metal posts, bolts, washers, keeper plates, and nuts shall be according to the manufacturer's specifications and as specified in the Contract Documents.

All metal posts shall be hot dip galvanized after fabrication according to ASTM A 123.

All sign hardware shall be hot dip galvanized according to ASTM A 153.

709.05.03 Signs

Signs shall be according to OPSS 2001.

709.07 CONSTRUCTION

709.07.01 General

Intermediate sign support systems shall be installed as specified in the Contract Documents and according to the manufacturer's instructions at locations specified in the Contract Documents. Installers shall be trained by the manufacturer's direct representative.

All sign boards shall be installed according to OTM Book 1B and as specified in the Contract Documents.

All sign boards shall be installed, relocated, or removed at locations specified in the Contract Documents. Sign boards shall be installed so that they do not obstruct and are not obstructed by existing permanent sign boards or other objects. The Contract Administrator shall be notified prior to installation of sign supports if it is not possible to install a new or relocated sign board as specified in the Contract Documents due to this requirement.

Sign boards shall be covered temporarily for traffic operational reasons when directed by the Contract Administrator. Sign boards shall be covered so they are not visible to approaching motorists. The cover shall remain securely in place until the sign boards are appropriate for display as directed by the Contract Administrator. The covering material shall not damage or make any marks on the sign boards.

Acceptable material from post hole excavation shall be used as backfill around posts and compacted according to OPSS 501.

Posts shall be plumb within a tolerance of ± 20 mm. The sign board shall be levelled on a two-post system within a tolerance of ± 10 mm.

Damaged and cut areas of hot dip galvanized coatings on any galvanized components shall be repaired according to ASTM A 780.

709.07.02 Sign Board Supply

Sign boards shall be supplied by the Owner or by the Contractor as specified in the Contract Documents.

709.07.02.01 Owner Supplied Sign Boards

709.07.02.01.01 Sign Board Ordering

The Contractor shall submit a list of sign boards required for this Contract to the Contract Administrator. The list of sign boards shall contain the quantity and details of the sign boards and the date for pick up by the Contractor. The list of sign boards shall be submitted a minimum of 12 weeks prior to the pickup date.

709.07.02.01.02 Sign Board Pickup

The Contractor shall pickup all the ordered sign boards on the list of required sign boards at a location provided in the Contract Documents to be supplied by the Owner within 10 Business Days of receiving notice from the Contract Administrator that the sign boards are ready for pickup. The Contractor shall ensure that all sign boards are safely secured and packaged prior to transporting the sign boards.

709.07.02.01.03 Sign Board Confirmation and Inspection

The Contractor shall within 5 Business Days confirm in writing with the Contract Administrator that all the ordered sign boards were received in accordance with the list of required sign boards. The Owner shall be notified of any incorrect sign boards identified by the Contractor. The Contractor shall be responsible for the cost of replacing all damaged, missing, and incorrect sign boards subsequent to the Contractor's order confirmation.

709.07.02.02 Contractor Supplied Sign Boards

The Contractor shall supply all sign boards as specified in the Contract Documents.

709.07.03 New Sign Boards

New sign boards shall be attached to new sign support systems with sign hardware as specified in the Contract Documents.

709.07.04 Relocation of Sign Boards

Relocated sign boards shall be attached to new support systems with sign hardware as specified in the Contract Documents. No portion of the existing sign board, support system, and sign hardware shall be left at the original sign location and any excess material including support system and sign hardware shall be managed as specified in the Contract Documents or as directed by the Contract Administrator.

709.07.05 Removal of Sign Boards

No portion of the removed sign board, support system, and sign hardware shall be left at the original sign location.

709.07.06 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

709.09.0 MEASUREMENT FOR PAYMENT

709.09.01 Actual Measurement

709.09.01.01 Intermediate Signs, Ground Mounted, New

For measurement purposes, a count shall be made of the number of new intermediate sign assemblies installed.

709.09.01.02 Intermediate Signs, Relocation

For measurement purposes, a count shall be made of the number of intermediate sign assemblies relocated.

709.09.01.03 Intermediate Signs, Removal

For measurement purposes, a count shall be made of the number of intermediate sign assemblies removed.

709.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clause under Actual Measurement.

709.10.0 BASIS OF PAYMENT

709.10.01 Intermediate Signs, Ground Mounted, New - Item
Intermediate Signs, Relocation - Item
Intermediate Signs, Removal - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Costs associated with any required repairs or removals and replacements of defective materials shall be the Contractor's responsibility at no additional cost to the Owner.

Appendix 709-A, November 2018
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- New sign boards material requirements. (709.05.01)

- Locations of sign boards to be installed, relocated, or removed. (709.07.01)

- If sign boards are to be supplied by the Owner or by the Contractor. (709.07.02)

- Location of sign board pickup. (709.07.02.01.02)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 992.101	Intermediate Sign Support System, Slip-Safe Supreme Rib-Bak Breakaway System, Components
OPSD 992.210	Intermediate Sign Support System, Slip-Safe Supreme Rib-Bak Breakaway System, Installation – Double Post Assembly

Note: The MUNI implemented in November 2021 replaces OPSS 710 COMMON, November 2010 with no technical content changes.

CONSTRUCTION SPECIFICATION FOR PAVEMENT MARKING

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710.10 **BASIS OF PAYMENT**

APPENDICES

710-A **Commentary**

710.01 SCOPE

This specification covers the requirements for the application of pavement markings onto bituminous or concrete pavement.

710.01.01 Specification Significance and Use

This specification has been developed for use in municipal-oriented Contracts. The administration, testing, and payment policies, procedures, and practices reflected in this specification correspond to those used by many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

710.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

710.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications or publications:

Ontario Provincial Standard Specifications, Material

OPSS 1712	Organic Solvent Based Traffic Paint
OPSS 1713	Thermoplastic Pavement Marking Materials
OPSS 1714	Field Reacted, Polymeric Pavement Marking Materials
OPSS 1715	Preformed Plastic Pavement Marking Tape
OPSS 1716	Water-Borne Traffic Paint
OPSS 1750	Traffic Paint Reflectorizing Glass Beads

Ontario Ministry of Transportation Publications

Manual of Uniform Traffic Control Devices for Ontario, MUTCD

710.03 DEFINITIONS

For the purpose of this specification, the following definitions shall apply:

Durable Pavement Markings mean pavement markings produced by either thermoplastics, field reacted polymer, or a preformed plastic tape of durable type.

Field Reacted Polymeric Pavement Marking Material means a pavement marking material consisting of two separate components, a polymerizable component and a curing agent or a polymerization catalyst. These two components are designed to be mixed at the site at recommended proportions and applied during the pot life of the mixture.

Hot Applied Thermoplastic Pavement Marking Material means a thermoplastic material that is specifically formulated for hot spray or screed application.

Organic Solvent Based Traffic Paint means a traffic paint whose components are carried in an organic solvent system and will form a solid paint film on evaporation of the solvent after application.

Pavement Markings mean markings on pavements used to delineate vehicle operating limits on highways and streets according to the size and shape, as specified in the MUTCD.

Permanent Pavement Markings mean pavement markings placed other than temporary pavement markings or short term pavement markings.

Preformed Plastic Pavement Marking Tape means plastic material specifically designed and preformed into pliable rolls or ribbons of various lengths and widths or into symbols.

Premarking means the indicating marks required to identify the position of pavement markings.

Reflectorization means a material, treatment, or process to enable incident light to be returned in high proportions in the general direction of the light source.

Short Term Pavement Markings mean the markings placed prior to the placement of permanent pavement markings on any milled, levelling, binder or top course pavements where existing lane widths, arrangements, and alignments are maintained.

Temporary Pavement Markings mean pavement markings placed on temporary roadway surfaces or alignments during construction.

Temporary Pavement Marking Material means pavement marking materials designed to maintain a service life of a minimum of three months.

Temporary Pavement Markings – Removable mean pavement markings using materials designed to be removed after use.

Temporary Raised Pavement Markers mean raised reflective devices.

Traffic Paint means a paint specifically formulated for use as a pavement marking.

Water-Borne Traffic Paint means a traffic paint whose components are carried in water either as an emulsion or a dispersion and will form a solid paint film on deposition and evaporation of water and volatiles after application.

710.04 DESIGN AND SUBMISSION REQUIREMENTS

710.04.01 General

One-litre samples of solvent based and/or water-borne paint; 500 g samples of thermoplastics; 500 g sample of field reacted polymeric materials with an adequate amount of catalyst or curing agent; one metre section of preformed pavement marking tape and a 200 g sample of reflectorizing glass beads to be used on the Contract shall be supplied to the Owner one month prior to use, prepaid, by the Contractor.

If any sample fails to conform to the specification requirements, none of the batch from which the sample was taken shall be used. New batches shall be obtained at no additional cost to the Owner and the new batches shall be tested until an acceptable batch is obtained.

710.05 MATERIALS

710.05.01 Classification

Pavement markings are classified into the following types based on performance requirements:

a) Traffic Paint

b) Pavement Marking - Durable

c) Pavement Marking - Temporary

d) Pavement Marking - Temporary - Removable

710.05.02 Organic Solvent Based Traffic

Organic solvent based traffic paint shall be according to OPSS 1712.

710.05.03 Thermoplastic Pavement Marking Materials

Thermoplastic pavement marking materials shall be according to OPSS 1713.

710.05.04 Field Reacted Polymeric Pavement Marking Materials

Field reacted polymeric pavement marking materials shall be according to OPSS 1714.

710.05.05 Preformed Plastic Pavement Marking Tape

Preformed plastic pavement marking tape shall be according to OPSS 1715.

710.05.06 Water-Borne Traffic Paint

Water-borne traffic paint shall be according to OPSS 1716.

710.05.07 Special Considerations

Materials not conforming to the no-tracking time requirements of the applicable specification, may be used when approved by the Owner.

710.06 EQUIPMENT

710.06.01 General

The equipment to be used for application or installation of pavement markings shall be as recommended by the manufacturer of the respective pavement marking material.

710.06.02 Spray Equipment

710.06.02.01 General

Spray equipment shall be used for application of solvent based traffic paint, water-borne traffic paint, thermoplastics, and field reacted polymeric material recommended for spray application.

Spray equipment shall be fabricated from materials that will not contaminate the traffic paint and other pavement marking materials.

The spray equipment shall provide a uniform stripe to the required width and thickness, with sharp edges without excessive splatter or overspray. The equipment shall have the capability to provide pavement markings according to the MUTCD. The equipment shall be provided with glass bead dispenser to apply overlay glass beads at the recommended rate.

710.06.02.02 Thermoplastic Pavement Markings

Equipment to be used for the application of thermoplastic material shall be capable of mixing, maintaining, and applying the material at the recommended temperature.

710.06.03 Other Methods of Application

Field reacted polymeric materials and thermoplastics shall be applied using a screed applicator.

Preformed plastic tape shall be installed according to the manufacturer's recommendations.

710.07 CONSTRUCTION

710.07.01 General

As part of the work, the Contractor shall supply pavement marking and symbols according to the applicable shapes and sizes as specified in the MUTCD.

The Contractor shall apply the pavement marking and symbols according to the Contract Drawings, when provided, MUTCD and the manufacturer's recommendations.

The work of pavement marking includes: providing samples of materials for testing for conformity to the appropriate material specification, surface preparation, pavement marking obliterating, premarking, application of temporary, short term, and permanent pavement markings.

Where the pavement marking scheme is not shown in the Contract Drawings, it shall be according to the MUTCD or be provided by the Owner.

710.07.02 Surface Preparation

The pavement surface must be clean and dry. Contaminants such as dirt, loose asphalt particles, and oily residue shall be removed prior to application of pavement marking.

710.07.03 Pavement Marking Obliterating

Durable markings and traffic paint shall be obliterated or removed using the method specified in the Contract Documents at the locations specified.

710.07.04 Premarking

The Contractor shall provide the necessary measurements required to establish the position of all pavement markings.

710.07.05 Temporary Pavement Marking

Temporary markings shall include surface preparation, premarking, and placement of temporary markings.

Temporary pavement marking shall be placed on temporary road surfaces prior to the opening to the general public according to the MUTCD or as specified in the Contract Documents.

710.07.06 Short Term Pavement Marking

Short term pavement marking is required when a paved roadway is to be opened to the general public prior to the application of permanent pavement markings.

As part of the work of pavement marking, the Contractor shall apply short term pavement markings for the centreline and lane lines.

Short term pavement markings shall be applied according to the MUTCD and as amended by Table 1.

Short term pavement markings shall not conflict with permanent pavement markings.

Short term pavement markings placed on final surface course shall be of the removable type.

A temporary raised pavement marker may be used in place of one 0.3 m line.

710.07.07 Permanent Pavement Marking

Permanent pavement marking includes surface preparation, premarking, short term pavement marking, removal of short term pavement markings, and placement of permanent pavement markings.

When permanent pavement markings cannot be placed prior to the opening to traffic, Freeways, Major, and Minor Roadways must have short term pavement markings according to Division C of the MUTCD and as amended by Table 1.

Permanent pavement markings must be in place and maintained prior to any winter shut down.

TABLE 1
Short Term Pavement Markings

Type of Marking Note 1	Type of Roadway	Length of Lines Min.	Length of Gaps Max.	Length of Time Before Permanent Markings are Placed Max.
A	Freeway - six Lanes or Greater, Three Lanes per Direction	3 m Note 2	9 m Note 2	15 Working Days
B	Freeway - Four Lanes, Two Lanes per Direction	0.3 m	15 m	15 Working Days
C	Major Roadways- Six Lanes or Greater, Three Lanes per Direction	3 m Note 2	6 m Note 2	15 Working Days
D	Major Roadways - Four Lanes, or Less	0.3 m	15 m	15 Working Days
E	Minor Roadways	0.3 m	15 m	20 Working Days

Notes: 1. Type of marking as specified elsewhere in the Contract.
2. Same as MUTCD.

710.07.08 Selection of Materials

When the item Pavement Marking, or Pavement Marking Symbols, is called for, the Contractor is restricted to traffic paint.

When the item Pavement Marking, Durable, or Pavement Marking Symbols, Durable is called for, the Contractor's choice of material is restricted to:

a) Durable preformed plastic tape.

b) Field reacted polymeric pavement marking material.

c) Thermoplastic pavement marking material.

When the item Pavement Marking, Temporary, or Pavement Marking Symbols, Temporary, is called for the Contractor may choose from all marking materials.

When the item Pavement Marking, Temporary Removable, or Pavement Marking Symbols, Temporary - Removable is called for, the Contractor's choice of material is restricted to temporary preformed, removable pavement marking tape.

Selection of pavement marking material for use on a particular type of pavement surface shall according to the manufacturer's recommendations.

710.07.09 Application

710.07.09.01 General

All pavement markings shall be accurately spaced and present a clean-cut, uniform appearance during either the day or night.

The application of pavement marking materials shall be according to the following requirements and the manufacturer's recommendations.

710.07.09.02 Organic Solvent Based Traffic Paint

Paint shall be applied when the pavement surface temperature is 5 °C and above, unless otherwise approved in writing by the Owner.

Paint shall be applied at a rate which results in a uniform thickness of 230 microns ± 25 microns dry film. Reflectorizing glass beads according to OPSS 1750, shall be applied uniformly at a rate as shown below, immediately after paint application to ensure embedment of the glass beads.

Overlay glass beads shall not be applied on to black paint which is used for obliterating previous markings.

Rate of Application for Overlay Glass Beads per litre of Traffic Paint

% Volume Solids of Traffic Paint	Glass Beads Required in kg
40-56	0.7
57-70	0.8

The paint temperature shall be between 40 and 70 °C when applied to the pavement.

710.07.09.03 Water-Borne Traffic Paint

Paint shall be applied as specified in clause 710.07.09.02 except that the pavement surface temperature shall be 10 °C and above.

710.07.09.04 Thermoplastic Pavement Marking Material

The material shall be applied when the pavement surface temperature is 5 °C and above. The maximum relative humidity shall be 70%. At pavement surface temperatures below 5 °C, the pavement shall be preheated immediately prior to material application.

Thermoplastics shall be applied at a rate which results in a uniform thickness of 1.90 mm ± 0.40 mm, measured dry. Markings shall not be applied over pavement joints.

Reflectorizing glass beads according to OPSS 1750, with the exception of the requirements for silicone coating shall be applied uniformly at a rate of 1.5 kg ± 0.10 kg per 10 m^2 of marking immediately after marking material applications and before the material hardens.

710.07.09.05 Field Reacted Polymeric Pavement Marking Materials

Field reacted polymeric pavement marking materials which are recommended for screed application shall be applied at a rate which results in a uniform thickness of 1.90 mm ± 0.40 mm, measured dry. Markings shall not be applied over pavement joints.

Materials shall be applied when the pavement surface temperature is 5 °C and above. The maximum surface temperature shall be 35 °C. The maximum relative humidity shall be 70%.

Reflectorizing glass beads according to OPSS 1750, with the exception of the requirement for silicone coating, shall be applied uniformly at a rate of 1.5 kg ± 0.10 kg per 10 m^2 of marking, immediately before the material hardens.

Field reacted polymeric pavement marking materials recommended for spray application shall be applied at a uniform thickness of 0.30 mm ± 0.15 mm, unless otherwise approved in writing by the Owner.

710.07.09.06 Preformed Plastic Tape

The tape shall be applied when the pavement surface temperature is 21 °C and above. The maximum relative humidity shall be 70%.

Joints of marking tape shall be butt joints without overlaps. Preformed markings shall not be applied over pavement joints.

710.07.09.07 Pavement Marking, Temporary Removable

Temporary removable pavement markings shall be applied according to the manufacturer's recommendation and shall be removed as specified. Removed material shall be disposed of outside the right-of-way.

710.07.09.08 Raised Pavement Markers, Temporary

The Contractor shall supply and install temporary raised pavement markers according to the Owner's requirements and the manufacturer's recommendations. Markers used shall be capable of remaining in place for a period of one to six months as specified in the Contract Documents. Temporary raised pavement markers shall be removed as specified in the Contract Documents. Removed material shall be disposed of outside the right-of-way.

710.08 QUALITY ASSURANCE

710.08.01 General

Random sampling may be carried out by the Owner during material application to assess line quality.

710.08.02 Line Quality

Line width, thickness, the nature of the edges, and uniformity in appearance will be assessed by the Owner. The dry film thickness will be measured by a paint inspection gauge or a coating thickness gauge.

Glass bead distribution will be inspected for evenness in distribution, degree of embedment, and retroreflectance.

710.08.03 Measurement of Temperature and Humidity

The testing of ambient and surface temperature will be by thermometer, and surface thermometer, respectively. Humidity will be measured using recording hygrometer.

710.09 MEASUREMENT FOR PAYMENT

710.09.01 Actual Measurement

710.09.01.01 Pavement Marking
Pavement Marking, Durable
Pavement Marking, Temporary
Pavement Marking, Temporary - Removable
Pavement Marking Obliterating

Measurement of pavement marking shall be by the horizontal length in metres of 10 cm wide line excluding gaps. Wider lines are measured in 10 cm equivalents.

Each symbol to be obliterated shall be approximately equated in area to a 10 cm wide line.

710.09.01.02 Pavement Marking Symbols
Pavement Marking Symbols, Durable
Pavement Marking Symbols, Temporary
Pavement Marking Symbols, Temporary - Removable
Raised Pavement Markers, Temporary

For measurement purposes, a count shall be made of the number of pavement marking symbols and raised pavement markers.

710.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

710.10 BASIS OF PAYMENT

710.10.01 Pavement Marking - Item
Pavement Marking Symbols - Item
Pavement Marking, Durable - Item
Pavement Marking Symbols, Durable - Item
Pavement Marking, Temporary - Item
Pavement Marking Symbols, Temporary - Item
Pavement Marking, Temporary Removable - Item
Pavement Marking Symbols, Temporary - Removable - Item
Raised Pavement Markers, Temporary - Item
Pavement Marking Obliterating - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material required to do the work.

Appendix 710-A, November 2021
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Method and locations of markings and paint obliteration and removal. (710.07.03)

- Temporary pavement marking requirements. (710.07.05)

- Type of markings. (710.07.07)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

CONSTRUCTION SPECIFICATION FOR HIGH TENSION CABLE GUIDE RAIL AND TERMINAL SYSTEMS

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720.08 **QUALITY ASSURANCE - Not Used**

720.09 **MEASUREMENT FOR PAYMENT**

720.10 **BASIS OF PAYMENT**

APPENDICES

720-A **Commentary**

720.01 SCOPE

This specification covers the requirements for the installation of high tension cable guide rail and terminal systems.

720.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

720.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

720.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 501 Compacting

Ontario Provincial Standard Specifications, Material

OPSS 1010 Aggregates - Base, Subbase, Select Subgrade, and Backfill Material

Ontario Ministry of Transportation Publications

Ontario Traffic Manual (OTM):
Book 6 - Warning Signs
Book 11 - Pavement, Hazard and Delineation Markings

ASTM International

A 123/A 123M-15	Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
A 153/A 153M-16a	Zinc Coating (Hot-Dip) on Iron and Steel Hardware
A 780/A 780M-09 (2015)	Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings

American Association of State Highway and Transportation Officials (AASHTO)

M 30-15 Standard Specification for Metallic-Coated Steel Wire Rope and Fittings for Highway Guardrail

American Society of Mechanical Engineers (ASME)

B1.13M-2005 Metric Screw Threads: M Profile

720.04 DESIGN AND SUBMISSION REQUIREMENTS

720.04.01 Submission Requirements

Installation of the high tension cable guide rail shall not commence until the Contract Administrator has received a copy of the manufacturer's installation instructions.

720.05 MATERIALS

720.05.01 General

All supplied system components shall be according to the manufacturer's specifications.

720.05.02 High Tension Three Cable Guide Rail and Terminal Systems

The names of systems and manufacturers acceptable for the High Tension Three Cable Guide Rail - Shoulder Installation are shown in Table 1.

The names of systems and manufacturers acceptable for the High Tension Three Cable Guide Rail - Slope Installation are shown in Table 2.

The names of systems and manufacturers acceptable for the High Tension Cable Guide Rail Terminal System are shown in Table 3.

720.05.03 Posts

Guide rail posts and terminal posts shall be according to manufacturer's specifications.

Object marker posts shall be perforated steel U channel, 2.44 m long with 11 mm diameter holes spaced on 50 mm centres, minimum weight of 4.46 kg/m, and hot dip galvanized according to ASTM A 123.

720.05.04 Guide Rail Cable

Guide rail cable shall be 19 mm diameter, 3 by 7 construction steel wire rope according to AASHTO M 30 with a minimum breaking strength of 173.5 kN and Type I Class A zinc coating.

Steel wire rope shall be factory pre-stretched to exhibit a minimum modulus of elasticity of 81,393 MPa.

Coils and reels of the guide rail cable shall be identified by a firmly attached strong durable tag on which the following information is indelibly recorded:

a) AASHTO / ASTM standard designation.

b) Length.

c) Nominal diameter of wire rope.

d) Type of strand construction.

e) Class of galvanized coating.

f) Mass of rope.

g) Modulus of elasticity.

h) Name or trademark of the manufacturer and location of origin.

720.05.05 Cable Hardware

Threaded terminals, turnbuckles, and anchor fittings shall be according to ASME B1.13M and have a minimum breaking strength of 160.1 kN. Hardware shall be hot dip galvanized after fabrication according to ASTM A 123 or ASTM A 153.

Fittings shall be of the swage type. Swaged fittings may be shop or field swaged. Stud assemblies and cable ends shall be 25 mm in diameter.

Turnbuckles shall be of the open body style.

720.05.06 Reflectors

Retroreflective sheeting for adherence to galvanized steel posts shall be 3M 3910 Diamond Grade and as specified in the Contract Documents.

Sheeting colour shall be according to OTM Book 11.

720.07 CONSTRUCTION

720.07.01 General

High tension cable guide rail systems and terminal systems shall be installed at locations specified in the Contract Documents according to manufacturer's instructions by installers trained by the manufacturer's direct representative.

Damaged areas of hot dip galvanized coatings on any galvanized component shall be repaired according to ASTM A 780.

720.07.02 Terminal Systems

Excavation for placement of terminal systems shall be as specified in the Contract Documents.

Bedding and backfill for terminal systems shall be Granular A according to OPSS 1010. Bedding shall be placed uncompacted and shall match the gradient of the roadway for installation of the anchor assembly. Backfill shall be compacted according to OPSS 501.

720.07.03 Posts

All guide rail and terminal posts shall be set to the alignment specified in the Contract Documents, regardless of the material encountered. Installation of posts shall be accomplished with methods and equipment that leave the posts free of distortion, burring, and any other damage.

720.07.04 Cable Mounting Height

Cable mounting height for high tension three cable guide rail systems for shoulder installations shall be measured at the traffic face of the system from the top of the final shoulder grade to the centre of each cable.

Cable mounting height for high tension three cable guide rail systems for slope installations shall be measured from the top of the final shoulder grade at the breakpoint in the rounding to the centre of each cable.

Acceptable cable mounting height tolerances for high tension cable guide rail systems and terminal systems shall be according to Contract Documents ± 25 mm.

720.07.05 Turnbuckles

Turnbuckles shall be installed on each cable at a maximum spacing of 305 m. For installations less than 305 m in length, one turnbuckle per cable shall be installed near the centre of the installation.

All turnbuckles shall be positioned such that there is no interference with posts.

720.07.06 Cable Tension

Guide rail cable shall be systematically tensioned according to manufacturer's instructions, based on cable temperature, to the tension specified in the Contract Documents. For cable temperature values not specified in the Contract Documents, cable temperatures values and respective cable tension values shall be interpolated.

Tension testing equipment specified by the manufacturer and calibrated for local conditions shall be used to measure the tension in the cables. The same model of tension testing equipment shall be used throughout the duration of the Contract.

Tension in each cable shall be checked and the cable shall be retensioned if it does not meet the tension specified in the Contract Documents at the following intervals:

a) Initial installation.

b) 30 to 60 days after initial installation.

c) 10 to 12 months after Substantial Performance.

d) After any repairs.

A completed Cable Tension Log Sheet, provided in Table 4, shall be completed and submitted to the Contract Administrator for each installation and after each tension check and retensioning.

720.07.07 Reflectors

Retroreflective sheeting for reflectors on guide rail posts shall be installed between the top cable and the middle cable on the two sides of the posts perpendicular to traffic and on the traffic side of the posts at the following intervals:

a) Starting at first post adjacent to the terminal system at the approach end.

b) At a maximum interval of 20 m on tangent.

c) At intervals less than 20 m on curves as specified in OTM Book 11, Table 4.

d) Ending at last post adjacent to the terminal system at the leaving end.

Retroreflective sheeting for reflectors on terminal system posts shall be installed perpendicular to adjacent traffic on traffic side of post as specified in the Contract Documents.

Retroreflective sheeting shall be securely adhered to the applicable posts according to sheeting manufacturer's recommendations.

720.07.08 Object Markers and Oversize Snow Plow Markers

Object markers according to OTM Book 6, a Wz 2 oversize snow plow marker, and galvanized mounting hardware shall be installed adjacent to each high tension cable guide rail terminal system as specified in the Contract Documents.

The object marker and Wz 2 oversize snow plow marker shall be securely fastened to U channel object marker post according to the Contract Documents.

720.07.09 Quality Control

720.07.09.01 Certification of the Installation of High Tension Cable Guide Rail and Terminal Systems

Owner standard form PH CC 877, Certificate of the Installation of Safety Items, as specified in the Contract Documents, shall be submitted to the Contract Administrator for each installation.

720.07.10 Management of Excess Material

Management of excess material shall be as specified in the Contract Documents.

720.09.0 MEASUREMENT FOR PAYMENT

720.09.01 Actual Measurement

720.09.01.01 High Tension Three Cable Guide Rail

Measurement of high tension cable guide rail shall be by length in metres of the system installed including the length of the end terminals.

720.09.01.02 High Tension Cable Guide Rail Terminal System

For measurement purposes, a count shall be made of the number of complete terminal systems installed.

720.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

720.10 BASIS OF PAYMENT

High Tension Three Cable Guide Rail - Shoulder Installation - Item
High Tension Three Cable Guide Rail - Slope Installation - Item
High Tension Cable Guide Rail Terminal System - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Retensioning and any required repairs or removal and replacement of defective materials shall be the Contractor's responsibility at no additional cost to the Owner.

Table 1
High Tension Three Cable Guide Rail - Shoulder Installation

System	Manufacturer	Test Compliance
Safence High Tension Three-Cable Barrier	Gregory Industries, Inc.	AASHTO MASH TL-3

Table 2
High Tension Three Cable Guide Rail - Slope Installation

System	Manufacturer	Test Compliance
Safence High Tension Three-Cable Barrier	Gregory Industries, Inc.	AASHTO MASH TL-3

Table 3
High Tension Cable Guide Rail Terminal System

System	Manufacturer	Test Compliance
Safence Terminal	Gregory Industries, Inc.	NCHRP Report 350 TL-3

Table 4
Cable Tension Log Sheet

Region:	Highway:
Contract Number:	Installation Date:
Location (Sta. and L\R):	Name of System:
Contractor:	

Tension Check Interval	Date Of Check	Top Cable			Middle Cable			Bottom Cable			Hardware Replaced	Signature
		Temperature	Initial Tension	Final Tension	Temperature	Initial Tension	Final Tension	Temperature	Initial Tension	Final Tension		
Initial Installation			n / a			n / a			n / a			
30 to 60 Days After Initial Installation												
10 to 12 Months After Substantial Performance												
After Collision or Repair												
After Collision or Repair												

Appendix 720-A, April 2018
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- High tension cable rail system locations. (721.07.01)

High tension three cable guide rail (HT3CGR) may be installed on the inside and outside of horizontal curves with centreline radii of 250 m and greater.

One high tension cable guide rail terminal systems (HTCGRTS) is required at each end of a HT3CGR installation. There are no requirements for intermediate anchors within a HT3CGR installation. There are no transitions currently available that transition HT3CGR to or from steel beam guide rail or concrete barrier.

The granular base and earth or rock front slopes or side slopes for the roadway in vicinity of HTCGRTS shall be widened according to the applicable 200 series OPSD and detailed accordingly on the design cross sections to accommodate the HTCGRTS. For shoulder installations, the HTCGRTS is flared away from the edge of shoulder to provide a 0.6 m offset from edge of shoulder to the centre of anchor to minimize nuisance impacts and snow plow damage. For HT3CGR slope installations, the HTCGRTS does not need to be flared away from the shoulder, as the centre of anchor should already be offset approximately 0.45 m from the edge of shoulder. HTCGRTS are designed to release the cables from the anchor assembly when errant vehicles from either direction impact the terminal in vicinity of where the cables are attached to the anchor assembly.

Designers have the flexibility to extend the length of HT3CGR installations to a location where roadway widening requirements for the HTCGRTS can be accommodated.

Desirably, the area immediately downstream of the approach end of the HTCGRTS behind the HT3CGR where the cables are attached to the anchor assembly, should be traversable and clear of fixed obstacles for a minimum distance of 23.0 m long by 6.0 m wide according to the applicable 200 series OPSD.

Delineation of the HTCGRTS shall be provided at edge of shoulder adjacent to the approach and leaving ends of the HT3CGR installations according to the applicable 900 series OPSD.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Appendix 720-A

Related Ontario Provincial Standard Drawings

OPSD 202.040	Roadway Widening For High Tension Cable Terminals, Slope Installation
OPSD 202.041	Roadway Widening For High Tension Cable Terminals, Shoulder Installation
OPSD 913.220	Guide Rail System, High Tension Cable, Safence Terminal, 3-Cable, Slope Installation
OPSD 913.221	Guide Rail System, High Tension Cable, Safence Terminal, 3-Cable, Shoulder Installation
OPSD 913.222	Guide Rail System, High Tension Cable, Safence Terminal, 3-Cable, Terminal Posts – Component
OPSD 913.226	Guide Rail System, High Tension Cable, Safence Terminal, Steel Anchor Assembly – Component
OPSD 913.250	Guide Rail System, High Tension Cable, Safence, 3-Cable, Shoulder Installation
OPSD 913.251	Guide Rail System, High Tension Cable, Safence, 3-Cable, Slope Installation
OPSD 913.252	Guide Rail System, High Tension Cable, Safence, 3-Cable, Slope Installation Line Post – Component
OPSD 913.253	Guide Rail System, High Tension Cable, Safence, 3-Cable, Shoulder Installation Line Post – Component
OPSD 913.255	Guide Rail System, High Tension Cable, Safence, 3-Cable, Buried Obstacle Treatment Installation
OPSD 984.206	Guide Rail System, High Tension Cable, Delineation, Installation – Leaving End
OPSD 984.207	Guide Rail System, High Tension Cable, Delineation, Installation – Approach End

CONSTRUCTION SPECIFICATION FOR STEEL BEAM GUIDE RAIL AND ADJUSTMENT OF CABLE GUIDE RAIL

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721-A **Commentary**

721.01 SCOPE

This specification covers the requirements for the installation of steel beam guide rail and the adjustment of cable guide rail systems.

721.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

721.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

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721.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 501 Compacting

Ontario Provincial Standard Specifications, Material

OPSS 1350 Concrete - Materials and Production
OPSS 1503 Cable Guide Rail
OPSS 1504 Steel Beam Guide Rail
OPSS 1505 Channel Components for Steel Beam Guide Rail
OPSS 1601 Wood, Preservative Treatment, and Shop Fabrication

Ontario Ministry of Transportation Publications

Ontario Traffic Manual (OTM):
Book 11 - Pavement, Hazard and Delineation Markings

CSA Standards

G164-M92 (R2003) Hot Dip Galvanizing of Irregularly Shaped Articles
O56-10 (R2015) Round Wood Piles

ASTM International

A 36/A 36M-14	Carbon Structural Steel
A 780/A 780M-09 (2015)	Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
D 4956-17	Retroreflective Sheeting for Traffic Control

721.05 MATERIALS

721.05.01 Cable Guide Rail

Guide rail cable, fittings, cable clamps and nails, and steel sections for anchor blocks shall be according to OPSS 1503.

Guide rail posts shall be clean peeled according to CAN/CSA O56, and according to OPSS 1601.

Precast concrete anchor blocks shall be according to OPSS 1503.

Reflectorized strips on 0.5 mm thick aluminum sheet shall be according to OTM Book 11 and as specified in the Contract Documents.

721.05.02 Steel Beam Guide Rail

Steel beam guide rail shall be according to OPSS 1504.

Channel components shall be according to OPSS 1505.

Wooden posts and blocks shall be according to OPSS 1601.

Plastic blocks shall be as specified in the Contract Documents.

Steel sleeves and spacer tubes used in transition treatments to concrete structures shall be fabricated from Schedule 40 galvanized steel pipe.

Steel posts, sleeves, and spacer tubes shall be hot dip galvanized after fabrication according to CSA G164.

Steel posts shall be according to ASTM A 36.

Reflectors shall have a minimum reflective surface of 100 x 100 mm; high intensity retroreflective sheeting according to ASTM D 4956, Type VII; colour according to OTM Book 11; and flexibility to bend 90 degrees from vertical and self restore.

721.05.03 Fabricated Steel Bases

Fabricated steel bases shall be according to OPSS 1503.

721.05.04 Concrete

Concrete shall be according to OPSS 1350 with a nominal minimum 28-Day compressive strength of 30 MPa.

721.07 CONSTRUCTION

721.07.01 General

Guide rail systems shall be installed plumb and to the alignment and grade as specified in the Contract Documents, regardless of the material encountered.

Tops of wooden posts shall be cut as specified in the Contract Documents and treated with two coats of 2% copper napthenate wood preservative. Field applied wood preservative that comes in contact with any galvanized components shall be removed immediately.

Acceptable material from posthole or anchor block excavation shall be used as backfill around posts and compacted according to OPSS 501.

When required, fabricated steel bases shall be installed level and square to the centreline of the roadway.

Cut ends, field drilled holes, and damaged areas of hot dip galvanized coatings on any galvanized component shall be repaired according to ASTM A 780.

Flame cutting shall not be permitted.

721.07.02 Cable Guide Rail

721.07.02.01 Installation

Wooden posts shall be installed to the specified depth with the larger end of the post in the ground.

Cable shall be attached to guide rail posts using cable clamps and nail fasteners.

Cable mounting height shall be measured from the top of final shoulder grade at the post face. Cable height shall be adjusted to provide a smooth installation.

Cables shall be tensioned so that the sag between posts shall be a maximum of 6 mm.

Cable splices occurring on the same cable shall be spaced a minimum length of 15 m apart.

There shall be only one cable splice per panel, regardless of the number of cables in the system.

721.07.02.02 Anchor Blocks

Precast or cast-in-place cubical or cylindrical anchor blocks shall be installed as specified in the Contract Documents, regardless of the material encountered.

In porous or crumbly soil, forms for cast-in-place anchors shall be used to prevent contamination of the concrete. Forms may be left in place or removed.

Earth backfill and granular materials shall be compacted according to OPSS 501.

721.07.02.03 Reflectorized Strips

Reflectorized strips shall be installed:

a) starting at the second post from the approach end.

b) at a maximum interval of every fifth post on tangent.

c) at a maximum interval of every third post on curves.

d) ending on the second to last post.

The reflectorized strip shall be fastened on posts as specified in the Contract Documents using two 50 mm aluminum nails.

721.07.02.04 Adjust Cable Guide Rail

Cable guide rail shall be adjusted at locations as specified in the Contract Documents.

Cable guide rail adjustment shall be as specified in the Contract Documents and include:

a) the removal of the following:

   i. staples and spacers or cable clamps and nails
   ii. reflectorized strips
   iii. cables as salvage

b) the installation of the following:

   i. salvaged cables
   ii. new cable clamps and nails
   iii. new reflectorized strips

To facilitate cable tensioning, one new turnbuckle assembly shall be installed on each cable between each set of adjacent anchor blocks. Cables shall be tensioned so that the sag between posts shall be a maximum of 6 mm.

721.07.02.05 Cable Guide Rail Post Replacement

Existing cable guide rail posts shall be removed and replaced with new cable guide rail posts at locations as specified in the Contract Documents and installed as specified in the Cable Guide Rail Installation clause. Locations shall be confirmed with the Contractor Administrator prior to commencing the removal of existing posts.

721.07.03 Steel Beam Guide Rail

721.07.03.01 Installation

Steel beam guide rail shall be installed as specified in the Contract Documents.

Each steel beam guide rail installation may incorporate either steel posts with either plastic or routed wooden blocks or wooden posts with wooden blocks, but not both. Wooden posts shall only be permitted within steel post installations when wooden posts are specified for treatments. Extension of an existing wooden post installation using steel posts shall only be permitted when the extension length is greater than 100 m.

Different types of plastic and wooden blocks shall not be used together within a steel beam guide rail installation.

When a transition to a rigid obstacle is required, the offset block for the channel may be either wood or a pipe sleeve over the connecting bolt. The pipe sleeve shall be 89 mm OD galvanized steel pipe cut to the required length.

Backup plates, steel spacer tubes, and pipe sleeves shall be installed as specified in the Contract Documents.

All joints shall be lapped in the direction of traffic.

Bolts shall be tightened to 100 N·m. Bolts for wooden post installations shall be field cut as required to maintain a maximum protrusion of 10 mm beyond the nut. The cut end of the bolt shall be ground smooth with all sharp edges and burrs removed.

Steel beam guide rail mounting heights shall be measured vertically from the top of the steel beam guide rail.

Steel beam guide rail without channel mounting heights shall be within the following ranges:

a) 685 to 760 mm during construction and seasonal shutdown.

b) 685 to 735 mm upon completion of the work.

Steel beam guide rail with channel mounting heights shall be within the following ranges:

a) 685 to 785 mm during construction and seasonal shutdown.

b) 735 to 785 mm upon completion of the work.

Where curb with gutter is required, steel beam guide rail mounting heights shall be measured:

a) Vertically at face of steel beam guide rail, when face of steel beam guide rail is more than 300 mm beyond the gutter line.

b) Vertically at the gutter line, when face of steel beam guide rail is 300 mm or less beyond the gutter line.

Type M steel beam guide rail mounting heights shall be within the following ranges:

a) 710 to 810 mm during construction and seasonal shutdown.

b) 760 to 810 mm upon completion of the work.

Where curb with gutter is required with Type M steel beam guide rail, mounting heights shall be measured vertically at the inside edge of the concrete gutter.

Where sidewalk is required with Type M steel beam guide rail, mounting heights shall be measured vertically at the face of Type M steel beam guide rail.

721.07.03.02 Reflectors

Reflectors shall be installed:

a) starting at the fifth post from the approach end of a steel beam guide rail end treatment.

b) at a maximum interval of every tenth post on tangent.

c) as specified in OTM Book 11, Table 4, on curves.

d) ending on the last post of the steel beam guide rail installation.

e) on the posts at the four adjacent steel beam guide rail splices at the approach and leaving end of structures.

The reflector shall be fastened to the post using adhesives, bolts and nuts, or screws with reflective surfaces clear above the top of the posts. One-sided reflectors shall be installed on divided highways and two-sided reflectors shall be installed on undivided highways.

721.07.03.03 Steel Beam Guide Rail Structure Connections

Steel beam guide rail shall be connected to new or existing structure walls as specified in the Contract Documents.

721.07.03.04 Adjust Steel Beam Guide Rail

Steel beam guide rail shall be adjusted at locations as specified in the Contract Documents.

Steel beam rail elements, channel elements, and offset blocks shall be disassembled from the posts. Post bolts, washers, nuts and existing steel offset blocks shall be removed and disposed of as specified in the Contract Documents.

Steel beam rail elements, channel elements, wooden offset blocks, and plastic offset blocks, shall be salvaged for reinstallation. Washers from the front face of the existing steel beam guide rail shall not be reinstalled.

Salvaged steel beam rail elements, channel elements, and wooden or plastic offset blocks shall be reinstalled within the mounting height ranges as specified in the Steel Beam Guide Rail Installation clause using new post bolts, washers, and nuts.

For steel post adjustment, the post shall be raised a minimum of 50 mm above the specified height and then driven down to the required depth before the salvaged steel beam guide rail components are reinstalled. When existing steel offset blocks have been removed, new wooden or plastic offset blocks shall be installed. A new hole shall be field punched through the existing post as specified in the Contract Documents.

For wooden post adjustment, a new hole shall be field drilled through the existing post as specified in the Contract Documents. The top of the offset block shall not extend beyond the top of the existing post. When channel elements are being reinstalled, an additional hole shall be field drilled through the existing post as specified in the Contract Documents.

New reflectors shall be supplied and installed as specified in the Reflectors clause. When new reflectors are installed on a wooden post system, the reflector shall be installed on the approach transverse face of the wooden offset block with one edge 12 mm from edge of post.

721.07.04 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

721.09 MEASUREMENT FOR PAYMENT

721.09.01 Actual Measurement

721.09.01.01 Adjust Cable Guide Rail

Measurement of adjust cable guide rail shall be by length in metres along the centreline of the system from centre of anchor block to centre of anchor block at each end of an installation. No additions shall be made for the overlapping length of cable at intermediate anchor blocks.

721.09.01.02 Cable Guide Rail Post Replacement

For measurement purposes, a count shall be made of the number of cable guide rail post replacement installed.

721.09.01.03 Anchor Blocks

For measurement purposes, a count shall be made of the number of anchor blocks installed.

721.09.01.04 Single Rail Steel Beam Guide Rail
Single Rail Steel Beam Guide Rail with Channel
Double Rail Steel Beam Guide Rail
Steel Beam Barricade

Measurement of steel beam guide rail shall be by length in metres along the centreline of the system from end to end of each steel beam guide rail installation and does not include the terminal systems.

721.09.01.05 Adjust Steel Beam Guide Rail, Wooden Posts
Adjust Steel Beam Guide Rail, Steel Posts
Adjust Steel Beam Guide Rail, Steel Posts with Steel Offset Blocks

Measurement of adjust steel beam guide rail shall be by length in metres along the centreline of the adjusted system from end to end of each steel beam guide rail installation and includes the end treatments and terminal systems.

721.09.01.06 Steel Beam Guide Rail Structure Connections

For measurement purposes, a count shall be made of the number of steel beam guide rail structure connections installed.

721.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

721.10 BASIS OF PAYMENT

721.10.01 Adjust Cable Guide Rail - Item
Cable Guide Rail Post Replacement - Item
Anchor Blocks - Item
Single Rail Steel Beam Guide Rail - Item
Single Rail Steel Beam Guide Rail with Channel - Item
Double Rail Steel Beam Guide Rail - Item
Adjust Steel Beam Guide Rail, Wooden Posts - Item
Adjust Steel Beam Guide Rail, Steel Posts - Item
Adjust Steel Beam Guide Rail, Steel Posts with Steel Offset Blocks - Item
Steel Beam Guide Rail Structure Connections - Item
Steel Beam Barricade - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

When there is not a separate tender item for steel beam guide rail structure connections, payment at the Contract price for single rail steel beam guide rail with channel shall include full compensation for all labour, Equipment, and Material to do the work of connecting steel beam guide rail to a structure.

Costs associated with any required repairs or removal and replacement of defective materials shall be the Contractor's responsibility at no additional cost to the Owner.

Appendix 721-A, November 2018
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Guide rail system type (include OPSD number) and locations. (721.07.01)

- Cable guide rail to be adjusted. (721.07.02.04)

- Cable guide rail post to be replaced. (721.07.02.05)

- Steel beam guide rail to be adjusted. (721.07.03.04)

For Type M steel beam guide rail, use only MASH Terminal Systems.

Leaving end treatments should only be used on divided highways and ramps, when the leaving end of the installation is located beyond the clear zone for opposing traffic.

Height adjustments for steel beam guide rail with wooden post shall be a minimum of 50 mm.

Cable Guide Rail Adjustment:

Mounting height tolerances for cable guide rail (CGR) are provided in the MTO Roadside Safety Manual. The purpose of the Adjust Cable Guide Rail item is to allow for the adjustment of the mounting height of an existing CGR installation. Generally, adjustment is necessary at locations where the pavement rehabilitation strategy will raise the existing ground elevation adjacent to an existing guide rail installation. An evaluation of existing guide rail will provide the designer with an inventory of the type of existing guide rail systems as well as the existing mounting height.

When adjusting CGR systems, the posts remain in their current location and the cables are reinstalled at the new mounting height. If the CGR was installed according to OPSD 913.130, there should be approximately 150 mm of space available for adjustment assuming that this is the first adjustment. Cables are not to be installed within 200 mm of the top of the posts. This ensures that the cables do not interfere with the reflectorized strip.

The Adjust Cable Guide Rail tender item also includes the removal and replacement of cable clamps and nails, the installation of one new turnbuckle per cable between anchor blocks, and the installation of new reflectorized strips.

When the evaluation of the existing CGR indicates that the posts are in unsound condition, out of plumb, or cannot meet the mounting height tolerance, it may be necessary to replace some or all of the posts. The Cable Guide Rail Post Replacement tender item can be used to replace existing cable guide rail posts when the remainder of the components (i.e., cables and anchor blocks) are in satisfactory condition.

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Steel Beam Guide Rail Adjustment:

Mounting height tolerances for steel beam guide rail (SBGR) are specified in OPSS 721. There are three tender items available for adjustment of SBGR. The purpose of these items is to allow for the adjustment of the mounting height of an existing SBGR installation on wooden or steel posts. Generally, adjustment is necessary at locations where the pavement rehabilitation strategy will raise the existing ground elevation adjacent to an existing guide rail installation. An evaluation of the existing guide rail will provide the designer with an inventory of the type of existing guide rail systems as well as existing mounting height. Existing SBGR installations may consist of the following configurations:

a) Wooden posts with wooden offset blocks:

   Although still installed today, these systems were used primarily in the years prior to implementation of SBGR on steel posts in 1995. When adjusting these systems, the posts remain in their current location, but the offset block and rail (and channel, where necessary) are reinstalled at the new mounting height. If the guide rail was installed according to OPSD 912.140, there should be approximately 150 mm of space available for adjustment assuming this is the first adjustment. The evaluation of existing guide rail should determine whether the existing installation can accommodate the proposed change in height.

b) Steel post with steel offset blocks:

   Steel post systems have been the most common since they were first implemented in 1995 mainly due to their relative ease of handling and installation. Steel offset blocks were used exclusively with steel post systems from 1995 through 2002 when the standard was revised to specify routed wooden blocks. When they are adjusted, existing steel post systems with steel offset blocks will be retrofitted with routed wooden or plastic offset blocks. This requires the punching of a new hole to accommodate the wooden or plastic offset block.

c) Steel posts with wooden or plastic offset blocks:

   From 2003 through the early 2008, steel post systems were installed exclusively with routed wooden offset blocks. In 2008, plastic offset blocks were implemented as an alternative to the routed wooden offset blocks. Since that time, steel post systems with plastic offset blocks have been the most common steel beam system.

Selection of the appropriate tender item for each installation will ensure that the Contractor will address the unique adjustment requirements of each system configuration.

Tender items for adjustment include the removal and replacement of existing hardware including bolts, washers, and nuts as well as the installation of new reflectors. For SBGR with steel offset blocks, replacement of steel offset blocks with plastic or wooden offset blocks is included.

Existing end terminals and treatments should be reviewed when SBGR is being considered for adjustment.

Existing end terminals may consist of eccentric loader terminal (ELT) systems, extruder terminal (ET) systems, or sequential kinking terminal (SKT) systems:

a) ELT Systems:

   - Consider replacement of ELT installations that are greater than or equal to 5 years in age with a new steel beam energy attenuating terminal (SBEAT) system. If the ELT system is located on a horizontal curve with a radius of less than 190m, a new ELT should be installed.

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b) SBEATs:

- Existing ET and SKT systems consist of several different variations on wooden and steel posts.

- Consider replacement of ET and SKT system installations on wooden posts with a new SBEAT System.

- ET and SKT systems on steel posts that are in good condition may be adjusted.

Existing leaving end treatments consisting of buried leaving end treatments (formerly OPSD 912.233) or upright fishtail ends:

a) Buried leaving end treatments are a challenge to adjust and could be replaced with a standard leaving end treatment according to OPSD 912.235. This would require the removal of 16 m of existing SBGR and subsequent installation of 4 m of new SBGR according to OPSD 912.235.

b) Existing upright fishtail type end treatments typically have been installed based on the extension requirements for unanchored guide rail in accordance with Table 3.4.2 in the MTO Roadside Safety Manual. When replacing an upright fishtail end treatment with a standard leaving end treatment, ensure that after removal of the unanchored end beyond the hazard that the 4 m of new SBGR in accordance with OPSD 912.235 extends beyond the hazard by 4 m.

c) Where an existing buried end treatment or upright fishtail end treatment is on the leaving end of a SBGR installation located on an undivided highway or at a location on a divided highway where the end of the SBGR is located within the clear zone for opposing traffic, the treatment should be considered for replacement with an end terminal.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 912.101 to 912.530	Steel Beam Guide Rail System
OPSD 913.101	Guide Rail System, Cable, Component - Cable Fittings
OPSD 913.135	Guide Rail System, Cable, Adjustment - Shoulder

CONSTRUCTION SPECIFICATION FOR ENERGY ATTENUATORS

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APPENDICES

723-A **Commentary**

723.01 SCOPE

This specification covers the requirements for the installation of permanent and temporary energy attenuators and relocation of temporary energy attenuators.

723.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

723.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

723.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 314 Untreated Granular Subbase, Base, Surface Shoulder, and Stockpiling
OPSS 510 Removal
OPSS 705 Flexible Delineator Posts
OPSS 740 Concrete Barriers
OPSS 904 Concrete Structures

Ontario Provincial Standard Specifications, Material

OPSS 1350 Concrete - Materials and Production
OPSS 1440 Steel Reinforcement for Concrete

Ontario Ministry of Transportation Publications

Ontario Traffic Manual (OTM):
Book 6 - Warning Signs

ASTM International

A123/A123M-17	Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
A780/A780M-20	Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
D4956-19	Retroreflective Sheeting for Traffic Control
F3125/F3125M-19e2	High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength

723.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Dual Duty means a new high exposure energy attenuator that is supplied and installed in a temporary configuration during construction, temporarily relocated as required, and then relocated to its permanent location prior to the end of the Work.

High Exposure means an energy attenuator that is installed in a location where the risk of impact is expected to be high such as in gore areas at exit ramps and express - collector transfers.

Reduced Exposure means a temporary energy attenuator that is installed in a location where the risk of impact is expected to be low. These energy attenuators should be specified in a location where they will be required for short duration of less than four months, are frequently relocated, and where they are not required during seasonal shutdown.

723.04 DESIGN AND SUBMISSION REQUIREMENTS

723.04.01 Design Requirements

The energy attenuator manufacturer shall complete the design of any non-standard details (e.g., a connection or transition to a rigid object other than a concrete barrier or temporary concrete barrier) at locations specified in the Contract Documents.

723.04.02 Submission Requirements

One copy of the manufacturer's installation instructions and Working Drawings shall be submitted to the Contract Administrator.

Installation of the energy attenuator shall not commence until the Contract Administrator has received the copy of the instructions and Working Drawings.

723.04.02.01 Submission Requirements for Non-Standard Details

Three copies of Working Drawings, prepared by the manufacturer, for any non-standard details shall be submitted to the Contract Administrator prior to the commencement of construction. The Working Drawings shall show full details of the materials and installation procedures. An Engineer's seal and signature shall be affixed on the Working Drawings verifying that the drawings are consistent with the Contract Documents. The submission of Working Drawings shall be accompanied by three copies of a letter that has been signed by the manufacturer, on company letterhead, summarizing the details of the proposed design.

Installation of the energy attenuator shall not commence until the Contract Administrator has received and accepted the copy of the letters and Working Drawings.

723.05 MATERIALS

723.05.01 General

All supplied system components shall be according to the manufacturer's specifications.

723.05.02 Energy Attenuator Systems

The names of systems acceptable for the Energy Attenuator - Permanent items are shown in Table 1.

The names of systems acceptable for the Energy Attenuator - Temporary items are shown in Table 2.

The Contractor shall have the option of supplying and installing any of these approved systems shown for the appropriate tender item.

When a specific energy attenuator system is specified in the Contract Documents, there shall not be an option of substitution for the energy attenuator system.

723.05.03 Concrete

Concrete for pads and anchor blocks shall be according to OPSS 1350 with a nominal minimum 28-Day compressive strength of 30 MPa.

723.05.04 Steel Reinforcement

Steel reinforcement shall be according to OPSS 1440.

723.05.05 Anchor Bolts

Anchor bolts shall be supplied and installed according to energy attenuator manufacturer recommendations.

723.05.06 Bolts for Connection of BB-BEAT System to Concrete Barrier

Bolts used to connect the BB-BEAT system to the concrete barrier shall be according to ASTM F3125 and shall be hot dip galvanized according to ASTM A123.

723.05.07 U Channel Posts

Posts shall be 2.44 m long perforated steel U channel with 11 mm diameter holes spaced on 50 mm centres, minimum weight of 4.46 kg/m, and hot dip galvanized according to ASTM A123.

723.05.08 Flexible Delineator Posts

Flexible delineator posts shall be according to OPSS 705. The post colour shall be orange.

723.05.09 Reflective Sheeting

Flexible delineator posts shall be outfitted with high intensity retroreflective sheeting according to ASTM D4956, Type IV; white colour; and to the dimensions specified in the Contract Documents.

723.05.10 Reuse of Materials

Notwithstanding subsection GC 5.02, Quality of Material, paragraph 01 of the General Conditions of Contract, the reuse of materials is permitted for temporary energy attenuator installations and relocations, provided the components have not been damaged to affect the safety performance of the system.

723.07 CONSTRUCTION

723.07.01 General

Permanent and temporary energy attenuators shall be installed according to manufacturer's instructions at locations specified in the Contract Documents. A reference for energy attenuator Contract Drawing Notation is shown in Table 3.

Energy attenuators shall not be placed on surfaces with a crossfall greater than 6%.

723.07.01.01 Foundation for TAU-M Systems

Existing or new 150 mm minimum thick asphalt over 150 mm minimum thick compacted granular base may be used to support the TAU-M energy attenuator for permanent and temporary installations. The asphalt shall extend a minimum of 500 mm beyond the anchor bolts. Braces and anchoring for asphalt shall be used when the TAU-M system is installed on asphalt over granular according to manufacturer's specifications.

723.07.02 Permanent Installation

723.07.02.01 New Concrete Pads

Levelling and site preparation required for the existing granular base shall be performed prior to placing the concrete pad. The concrete pad shall be constructed as specified in the Contract Documents. Concrete shall be placed, cured, and finished according to OPSS 904.

The granular base below new concrete pads shall be a minimum depth of 150 mm of existing or new Granular A and shall be according to OPSS 314.

723.07.02.02 Existing Concrete Surfaces and Pads

When specified in the Contract Documents, existing 200 mm thick concrete surfaces, pads, or precast pads may be used to support the energy attenuator.

723.07.02.03 Connection of BB-BEAT and QuadTrend Systems to Concrete Barrier

When the BB-BEAT or QuadTrend system is connected to new concrete barrier, the adjacent 4.0 m of concrete barrier shall be according to OPSS 740 and the Contract Documents.

When the BB-BEAT or QuadTrend system is connected to existing concrete barrier, the adjacent 4.0 m of existing concrete barrier shall be removed according to OPSS 510 and a new 4.0 m section of concrete barrier shall be installed according to OPSS 740 and the Contract Documents.

723.07.02.04 Rear Cable Anchor Blocks for QuadTrend Systems

Rear cable anchor blocks shall be as specified in the Contract Documents. In both earth and rock fills, rear cable anchor blocks shall be placed on slopes 3H:1V or flatter. The cable supplied with the unit shall be used to determine the proper location of the rear cable anchor block.

In porous or crumbly soils, forms for cast-in-place anchor blocks shall be used to prevent contamination of the concrete. Forms may be left in place or removed.

The top of the concrete block shall be flush with the embankment slope and the rear cable anchor assembly shall not protrude more than 100 mm above ground.

723.07.02.05 Damage to Galvanizing

Precautions shall be taken to protect galvanizing against damage. Minor abrasions shall be repaired according to ASTM A780. Components with major abrasions shall be replaced.

The method of repair for any damage shall be approved by the Contract Administrator prior to the commencement of such work.

723.07.02.06 Posts for BB-BEAT Systems

All posts shall be set to the alignment specified in the Contract Documents, regardless of the material encountered. Permissible tolerance for plumb shall be 20 mm maximum over the post length above the ground. The driving of posts shall be accomplished with methods and equipment that leave the posts free of distortion, burring, and any other damage.

All lower end posts shall be installed so that not more than 100 mm is exposed above finished grade.

723.07.03 Temporary Installation

723.07.03.01 New Concrete Pads

The concrete pad shall be as specified by the manufacturer.

723.07.03.02 Existing Concrete Surface

Existing 200 mm minimum thick concrete surfaces, pads, or precast pads may be used to support the energy attenuator.

723.07.03.03 Asphalt Over Concrete

Existing or new 75 mm minimum thick asphalt over 75 mm minimum thick concrete pavement may be used to support the energy attenuator.

723.07.03.04 Asphalt Over Compacted Granular

Existing or new 150 mm minimum thick asphalt over 150 mm minimum thick compacted granular base may be used to support the energy attenuator. The asphalt shall extend a minimum of 500 mm beyond the anchor bolts.

723.07.03.05 Reduced Exposure

When water filled energy attenuator systems are in use, the temperature shall be monitored on a daily basis. When the temperature is predicted to fall below freezing, antifreeze agents according to manufacturer recommendations shall be added to the water. The use of a water filled energy attenuator system when frozen is not permissible.

Water filled energy attenuator systems shall not be left in place during a seasonal shutdown period without approval from the Contract Administrator. When approval from the Contract Administrator is not granted, water filled energy attenuator systems shall be replaced with another approved energy attenuator listed for the reduced exposure tender item for the duration of the seasonal shutdown period.

Disposal of liquid materials shall be managed according to the Contract Documents.

723.07.03.06 Dual Duty

A new high exposure energy attenuator shall be supplied and installed in a temporary configuration during construction at the locations specified in the Contract Documents.

723.07.03.07 Relocation

Temporary energy attenuators, object markers, oversize snowplow markers, object marker posts, and flexible delineator posts shall be relocated as specified in the Contract Documents, including the removal of existing and installation of new anchor bolts and mounting hardware.

Prior to completion of the Contract, dual duty energy attenuators and associated object markers, oversize snowplow markers, and object marker posts including the replacement of anchor bolts and mounting hardware, shall be relocated to their permanent locations as specified in the Contract Documents and in accordance with the General and Permanent Installation subsections.

723.07.03.08 Permanent and Temporary Concrete Barriers

Temporary concrete barriers shall be modified and installed as specified in the Contract Documents and the modified surfaces shall be smooth. Temporary concrete barriers shall be anchored as specified in the Contract Documents.

Permanent existing concrete barriers shall be modified as specified in the Contract Documents and the modified surfaces shall be smooth.

723.07.04 Delineation

723.07.04.01 Object Markers and Oversize Snowplow Markers

A Wa-33 object marker according to OTM Book 6, a Wz-2 oversize snowplow marker, and galvanized mounting hardware shall be installed at each energy attenuator.

When installed on a paved surface, the object marker and oversize snowplow marker shall be integrally attached to a surface mounted flexible post. The signs and post shall be supplied by the manufacturer as a complete unit. The post shall have the ability to bend 90° from vertical and self-restore after impacts. The minimum outside diameter of the post shall be 60 mm. The post shall be anchored to the pavement according to manufacturer's recommendations.

When installed on a granular surface, the Wa-33 object marker and Wz-2 oversize snowplow marker shall be securely fastened to a U channel post and the post shall be direct buried to a minimum embedment depth of 900 mm.

Posts shall be installed at locations specified in the Contract Documents.

723.07.04.02 Flexible Delineator Posts

Flexible delineator posts shall be installed according to OPSS 705 at locations specified in the Contract Documents.

723.07.05 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

723.09 MEASUREMENT FOR PAYMENT

723.09.01 Actual Measurement

723.09.01.01

Energy Attenuator - Permanent, Narrow
Energy Attenuator - Permanent, Wide
Energy Attenuator - Permanent, Extra Wide
Energy Attenuator - Permanent, Super Wide
Energy Attenuator - Permanent, High Exposure
Energy Attenuator - Permanent, Single-Sided
Box Beam Bursting Energy Absorbing Terminal System - Permanent
Quadguard M10 System - Permanent
Quadguard Wide System - Permanent
Quadguard M10 Wide System - Permanent
Quadguard Extra Wide System - Permanent
Quadguard Super Wide System - Permanent
QuadTrend System - Permanent
Smart System - Permanent
TAU-M System - Permanent
TAU-II Wide System - Permanent
TAU-II Extra Wide System - Permanent
Hercules System - Permanent

For measurement purposes, a count shall be made of the number of complete energy attenuator systems installed.

723.09.01.02

Energy Attenuator - Temporary, Narrow
Energy Attenuator - Temporary, Wide
Energy Attenuator - Temporary, Extra Wide
Energy Attenuator - Temporary, Super Wide
Energy Attenuator - Temporary, Reduced Exposure
Energy Attenuator - Temporary, Dual Duty
ABSORB 350 System - Temporary
ABSORB-M System - Temporary
ACZ-350 System - Temporary
Quadguard M10 System - Temporary
Quadguard Wide System - Temporary
Quadguard Extra Wide System - Temporary
Quadguard Super Wide System - Temporary
SLED System - Temporary
Smart System - Temporary
TAU-M System - Temporary
TAU-II Wide System - Temporary
TAU-II Extra Wide System - Temporary
Hercules System - Temporary

For measurement purposes, a count shall be made of the number of complete energy attenuator systems installed and removed, up to the maximum number of systems required to be in place at any one time during the Contract.

723.09.01.03

Energy Attenuator - Relocation, Narrow
Energy Attenuator - Relocation, Wide
Energy Attenuator - Relocation, Extra Wide
Energy Attenuator - Relocation, Super Wide
Energy Attenuator - Relocation, Reduced Exposure
Energy Attenuator - Relocation, Dual Duty

ABSORB 350 System - Relocation
ABSORB-M System - Relocation
ACZ-350 System - Relocation
Quadguard M10 System - Relocation
Quadguard Wide System - Relocation
Quadguard Extra Wide System - Relocation
Quadguard Super Wide System - Relocation
SLED System - Relocation
Smart System - Relocation
TAU-M System - Relocation
TAU-II Wide System - Relocation
TAU-II Extra Wide System - Relocation
Hercules System - Relocation

For measurement purposes, a count shall be made of the number of complete energy attenuator systems relocated. Systems that are temporarily surplus and are required for future stages shall be paid for as one relocation for the combined moves into and out of storage, including any off-site storage required due to on-site restrictions.

723.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

723.10 BASIS OF PAYMENT

723.10.01

Energy Attenuator - Permanent, Narrow - Item
Energy Attenuator - Permanent, Wide - Item
Energy Attenuator - Permanent, Extra Wide – Item
Energy Attenuator - Permanent, Super Wide – Item
Energy Attenuator - Permanent, High Exposure - Item
Energy Attenuator - Permanent, Single-Sided - Item
Box Beam Bursting Energy Absorbing Terminal System - Permanent - Item
Quadguard M10 System - Permanent - Item
Quadguard Wide System - Permanent - Item
Quadguard M10 Wide System - Permanent - Item
Quadguard Extra Wide System - Permanent - Item
Quadguard Super Wide System - Permanent - Item
QuadTrend System - Permanent - Item
Smart System - Permanent - Item
TAU-M System - Permanent - Item
TAU-II Wide System - Permanent - Item
TAU-II Extra Wide System - Permanent - Item
Hercules System - Permanent - Item
Energy Attenuator - Temporary, Narrow - Item
Energy Attenuator - Temporary, Wide - Item
Energy Attenuator - Temporary, Extra Wide - Item
Energy Attenuator - Temporary, Super Wide - Item
Energy Attenuator - Temporary, Reduced Exposure - Item
Energy Attenuator - Temporary, Dual Duty - Item
ABSORB 350 System - Temporary - Item
ABSORB-M System - Temporary - Item
ACZ-350 System - Temporary - Item
Quadguard M10 System - Temporary - Item
Quadguard Wide System - Temporary - Item

Quadguard Extra Wide System - Temporary - Item
Quadguard Super Wide System - Temporary - Item
SLED System – Temporary - Item
Smart System - Temporary - Item
TAU-M System - Temporary - Item
TAU-II Wide System - Temporary - Item
TAU-II Extra Wide System - Temporary - Item
Hercules System - Temporary - Item
Energy Attenuator - Relocation, Narrow - Item
Energy Attenuator - Relocation, Wide - Item
Energy Attenuator - Relocation, Extra Wide - Item
Energy Attenuator - Relocation, Super Wide - Item
Energy Attenuator - Relocation, Reduced Exposure - Item
Energy Attenuator - Relocation, Dual Duty - Item
ABSORB 350 System - Relocation - Item
ABSORB-M System - Relocation - Item
ACZ-350 System - Relocation - Item
Quadguard M10 System - Relocation - Item
Quadguard Wide System - Relocation - Item
Quadguard Extra Wide System - Relocation - Item
Quadguard Super Wide System - Relocation - Item
SLED System - Relocation - Item
Smart System - Relocation - Item
TAU-M System - Relocation - Item
TAU-II Wide System - Relocation - Item
TAU-II Extra Wide System - Relocation - Item
Hercules System - Relocation - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

When the Contract contains separate items for the work required by this specification, payment shall be at the Contract price and according to the specification for such work.

Costs associated with any required removals and replacement or repairs of defective work and materials shall be the Contractor’s responsibility at no additional cost to the Owner.

TABLE 1
Energy Attenuator, Permanent

Energy Attenuator	NCHRP Report 350 or AASHTO MASH Crash Test Level		Permanent Installation					
	TL-2	TL-3	Narrow (NA)	Wide (WI)	Extra Wide (EW)	Super Wide (SW)	High Exposure (HE)	Single-Sided (SS)
BB-BEAT	No	Yes	No	No	No	No	No	Yes
Quadguard M10 System (Note 1)	Yes	Yes	Yes	No	No	No	No	No
Quadguard Wide System (Note 3)	Yes	Yes	No	Yes	No	No	No	No
Quadguard M10 Wide System (Notes 1 and 2)	No	Yes	No	Yes	No	No	No	No
Quadguard Extra Wide System	Yes	Yes	No	No	Yes	No	No	No
Quadguard Super Wide System	No	Yes	No	No	No	Yes	No	No
QuadTrend	No	Yes	No	No	No	No	No	Yes
Smart System	Yes	Yes	Yes	No	No	No	Yes	No
TAU-M System (Note 1)	Yes	Yes	Yes	No	No	No	No	No
TAU-II Wide System	Yes	Yes	No	Yes	No	No	No	No
TAU-II Extra Wide System	Yes	Yes	No	No	Yes	No	No	No
Hercules System (Note 1)	No	Yes	Yes	No	No	No	No	No

Notes:

1. AASHTO MASH crash test compliant system.

2. The Quadguard M10 Wide (meeting AASHTO MASH TL-3) shall be used for Permanent Unidirectional configurations requiring a TL-3 crash test compliant system. For Permanent Unidirectional configurations requiring a TL-2 crash test compliant system and for all Bidirectional configurations of Energy Attenuator, Wide, systems listed on Table 1 and meeting NCHRP Report 350 shall be used.

3. Bidirectional only.

TABLE 2
Energy Attenuator, Temporary

Energy Attenuator	NCHRP Report 350 or AASHTO MASH Crash Test Level		Temporary Installation					
	TL-2	TL-3	Reduced Exposure (RE) (Note 2)	Narrow (NA)	Wide (WI)	Extra Wide (EW)	Super Wide (SW)	Dual Duty (DD)
ABSORB 350 System	Yes	Yes	Yes	No	No	No	No	No
ABSORB-M System (Note 1)	Yes	Yes	Yes	No	No	No	No	No
ACZ 350 System	Yes	Yes	Yes	No	No	No	No	No
Quadguard M10 System (Note 1)	Yes	Yes	No	Yes	No	No	No	No
Quadguard Wide System	Yes	Yes	No	No	Yes	No	No	No
Quadguard Extra Wide System	Yes	Yes	No	No	No	Yes	No	No
Quadguard Super Wide System	No	Yes	No	No	No	No	Yes	No
SLED System	Yes	Yes	Yes	No	No	No	No	No
Smart System	Yes	Yes	Yes	Yes	No	No	No	Yes
TAU-M System (Note 1)	Yes	Yes	No	Yes	No	No	No	No
TAU-II Wide System	Yes	Yes	No	No	Yes	No	No	No
TAU-II Extra Wide System	Yes	Yes	No	No	No	Yes	No	No
Hercules System (Note 1)	No	Yes	No	Yes	No	No	No	No

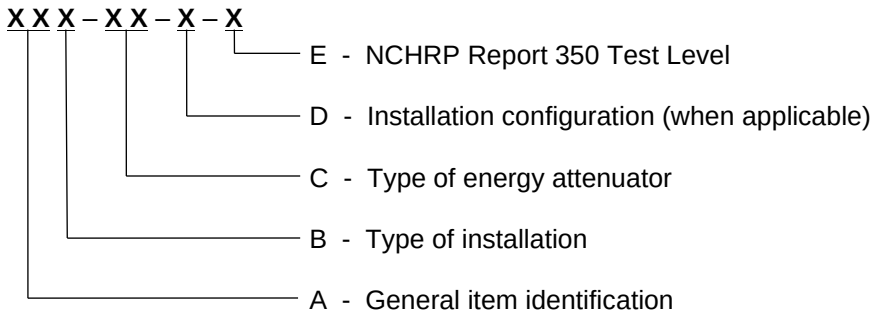
Notes:

1. AASHTO MASH crash test compliant system.

2. ABSORB 350 energy attenuator system shall be used when Movable Temporary Concrete Barrier is specified.

TABLE 3
Contract Drawing Notation

A	**EA** - Energy Attenuator
B	**P** - Permanent **T** - Temporary **R** - Relocation
C	**NA** - Narrow **WI** - Wide **EW** - Extra Wide **SW** - Super Wide **HE** - High Exposure **SS** - Single-Sided **RE** - Reduced Exposure **DD** - Dual Duty
D	**U** - Unidirectional **B** - Bidirectional **N** - Not applicable
E	**2** - NCHRP Report 350 TL-2 **3** - NCHRP Report 350 TL-3



Appendix 723-A, November 2021
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Energy attenuator system locations using the notation shown in Table 3. (723.07.01)

- Relocation of energy attenuators using the notation shown in Table 3. (723.07.01 and 723.07.03.06)

The designer should specify whether each system is TL-2 or TL-3 configuration. TL-2 configurations are required for low-speed installations with posted speeds of less than 70 km/h. TL-3 configurations are required for high-speed installations with posted speeds of 70 km/h and greater. Single-sided systems are only available in a TL-3 configuration. (723.07.01)

A permanent energy attenuator installation should include a new concrete pad (723.07.02.01). If an existing concrete surface or pad can be used to support the system, it should be specified in the Contract Documents (723.07.02.02). The designer should confirm that the existing concrete surface or pad is in good condition and will provide a smooth operating surface for the system.

The designer should confirm that one of the following foundation options is available for each temporary energy attenuator installation (723.07.03):

a) Existing concrete surface:
   - minimum 200 mm deep, 28 MPa minimum compressive strength

b) Asphalt over compacted granular:
   - minimum 150 mm asphalt over 150 mm minimum compacted granular
   - the asphalt must extend a minimum of 500 mm beyond the anchor bolts

c) Asphalt over concrete
   - minimum 75 mm asphalt over 75 mm minimum concrete, 28 MPa minimum compressive strength

The designer should confirm that the existing surface is in good condition and will provide a smooth operating surface for the system.

When a single-sided system is connected to existing concrete barrier as specified in the Contract Documents, the designer should include payment in the Contract Documents for the removal of the 4.0 m section of existing concrete barrier and placement of a new 4.0 m section adjacent to each system. (723.07.02.03)

Single-sided systems shall be installed with grading according to OPSD 202.033. Single-sided systems should not be installed in a location where backside hits towards the concrete barrier are possible (e.g., in gore areas), or in a narrow median where backside opposite direction hits are possible. The area behind and beyond the end terminal should be traversable and free of fixed objects. The minimum recommended rectangular area should be 6 m wide, measured behind and perpendicular to the back of the rail, by 22 m long, measured from the front face of the system and parallel to the system.
(723.07.02.03)

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When the reduced exposure tender item is selected, the designer should confirm that the following requirements for water filled energy attenuator systems are satisfied (723.07.03.04):

a) Water filled energy attenuator systems shall be installed at an offset of not less than 1.0 m from the edge of the travelled way.

b) When installed adjacent to an existing guide rail system, the clearance shall be less than or equal to 0.3 m or greater than or equal to 3.0 m. Otherwise, the area behind and beyond the water filled energy attenuator system shall be traversable and free of fixed objects. The minimum recommended rectangular area shall be 6 m wide, measured behind and perpendicular to the back of the system, by 22 m long, measured from the front face of the system and parallel to the system.

c) At a minimum, the first 16 m of temporary concrete barrier shall be placed tangential to the water filled energy attenuator system.

When the item for payment is Energy Attenuator, the designer should not include any drawings for specific energy attenuators in the Contract Documents.

Wherever possible, the designer should eliminate the use of curb with gutter in advance of and along the length of end treatments and crash cushions. See MTO Roadside Design Manual for additional information.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 202.033	Roadway Widening, Single Sided Energy Attenuating Terminals, Approach End
OPSD 922.131	Energy Attenuator, Crash Cushion, QuadTrend System, Installation - Concrete Barrier
OPSD 922.133	Energy Attenuator, Crash Cushion, QuadTrend System, Installation - Concrete Pad and Rear Cable Anchor Block
OPSD 923.001	Energy Attenuator, Crash Cushion, Narrow Systems, Component - Reinforced Concrete Pad
OPSD 923.002	Energy Attenuator, Crash Cushion, Component - Anchor Assembly
OPSD 923.004	Energy Attenuator, Crash Cushion, Wide Systems, Component - Reinforced Concrete Pad
OPSD 923.005	Energy Attenuator, Crash Cushion, Extra Wide Systems, Component - Reinforced Concrete Pad
OPSD 923.006	Energy Attenuator, Crash Cushion, Quadguard Super Wide System, Component - Reinforced Concrete Pad
OPSD 923.007	Energy Attenuator, Crash Cushion, Quadguard M10 Wide System, Component, Reinforced Concrete Pad
OPSD 923.008	Energy Attenuator, Crash Cushion, Hercules System, Component, Reinforced Concrete Pad
OPSD 923.010	Energy Attenuator, Crash Cushion, Narrow Systems, Component – Reinforced Precast Concrete Pad for Permanent Installation
OPSD 923.011	Energy Attenuator, Crash Cushion, Component – Reinforced Precast Concrete Pad for Modified Temporary Concrete Barrier
OPSD 923.141	Energy Attenuator, Crash Cushion, Quadguard M10 Wide System, Installation – Permanent, Unidirectional
OPSD 923.187	Energy Attenuator, Crash Cushion, Quadguard Wide System, Installation - Permanent, Bidirectional

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OPSD 923.188	Energy Attenuator, Crash Cushion, Quadguard Extra Wide System, Installation - Temporary, Unidirectional
OPSD 923.189	Energy Attenuator, Crash Cushion, Quadguard Extra Wide System, Installation - Temporary, Bidirectional
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OPSD 923.192	Energy Attenuator, Crash Cushion, Quadguard Super Wide System, Installation - Temporary, Unidirectional
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OPSD 923.198	Energy Attenuator, Crash Cushion, Quadguard M10 System, Installation – Permanent, Unidirectional
OPSD 923.199	Energy Attenuator, Crash Cushion, Quadguard M10 System, Installation – Permanent, Bidirectional
OPSD 923.384	Energy Attenuator, Crash Cushion, TAU-II Wide System, Installation - Temporary, Unidirectional
OPSD 923.385	Energy Attenuator, Crash Cushion, TAU-II Wide System, Installation - Temporary, Bidirectional
OPSD 923.386	Energy Attenuator, Crash Cushion, TAU-II Wide System, Installation - Permanent, Unidirectional
OPSD 923.387	Energy Attenuator, Crash Cushion, TAU-II Wide System, Installation - Permanent, Bidirectional
OPSD 923.388	Energy Attenuator, Crash Cushion, TAU-II Extra Wide System - TL-2, Installation - Temporary, Unidirectional
OPSD 923.389	Energy Attenuator, Crash Cushion, TAU-II Extra Wide System - TL-2, Installation - Temporary, Bidirectional
OPSD 923.390	Energy Attenuator, Crash Cushion, TAU-II Extra Wide System - TL-3, Installation - Temporary, Unidirectional
OPSD 923.391	Energy Attenuator, Crash Cushion, TAU-II Extra Wide System - TL-3, Installation - Temporary, Bidirectional
OPSD 923.392	Energy Attenuator, Crash Cushion, TAU-II Extra Wide System - TL-2, Installation - Permanent, Unidirectional
OPSD 923.393	Energy Attenuator, Crash Cushion, TAU-II Extra Wide System - TL-2, Installation - Permanent, Bidirectional
OPSD 923.394	Energy Attenuator, Crash Cushion, TAU-II Extra Wide System - TL-3, Installation - Permanent, Unidirectional
OPSD 923.395	Energy Attenuator, Crash Cushion, TAU-II Extra Wide System - TL-3, Installation - Permanent, Bidirectional
OPSD 923.396	Energy Attenuator, Crash Cushion, TAU-M System, Installation – Temporary, Unidirectional
OPSD 923.397	Energy Attenuator, Crash Cushion, TAU-M System, Installation – Temporary, Bidirectional

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OPSD 923.398	Energy Attenuator, Crash Cushion, TAU-M System, Installation – Permanent, Unidirectional
OPSD 923.399	Energy Attenuator, Crash Cushion, TAU-M System, Installation – Permanent, Bidirectional
OPSD 923.480	Energy Attenuator, Crash Cushion, Smart System, Installation - Temporary, Unidirectional
OPSD 923.481	Energy Attenuator, Crash Cushion, Smart System, Installation - Temporary, Bidirectional
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OPSD 923.483	Energy Attenuator, Crash Cushion, Smart System, Installation - Permanent, Bidirectional
OPSD 923.501	Energy Attenuator, Crash Cushion, Hercules System, Installation – Temporary, Unidirectional and Bidirectional
OPSD 923.502	Energy Attenuator, Crash Cushion, Hercules System, Installation – Permanent, Unidirectional and Bidirectional
OPSD 923.530	Energy Attenuator, Crash Cushion, Box Beam Bursting Energy Absorbing Terminal, Installation - Layout
OPSD 923.531	Energy Attenuator, Crash Cushion, Box Beam Bursting Energy Absorbing Terminal, Installation - Impact Head and Post
OPSD 924.131	Energy Attenuator, Crash Cushion, ABSORB 350 System, Installation - Temporary Concrete Barrier
OPSD 924.132	Energy Attenuator, Crash Cushion, ABSORB-M System TL-2, Installation – Temporary Concrete Barrier
OPSD 924.133	Energy Attenuator, Crash Cushion, ABSORB-M System TL-3, Installation – Temporary Concrete Barrier
OPSD 924.135	Energy Attenuator, Crash Cushion, ACZ-350 System, Installation - Temporary Concrete Barrier
OPSD 924.141	Energy Attenuator, Crash Cushion, SLED System, Installation – Temporary Concrete Barrier
OPSD 984.203	Energy Attenuator, Crash Cushion, Delineation, Installation - Temporary
OPSD 984.204	Energy Attenuator, Crash Cushion, Delineation, Installation - Permanent

CONSTRUCTION SPECIFICATION FOR GUIDE RAIL END TREATMENT - STEEL BEAM ENERGY ATTENUATING TERMINAL SYSTEMS

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732.10 **BASIS OF PAYMENT**

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732-A **Commentary**

732.01 SCOPE

This specification covers the requirements for the installation of steel beam energy attenuating terminal (SBEAT) systems.

732.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

732.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

732.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Ministry of Transportation Publications

Ontario Traffic Manual (OTM):
Book 6 - Warning Signs

ASTM International

A 123/A 123M-17	Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
A 780/A 780M-09(R2015)	Standard Practice for Repair of Damaged and Uncoated Areas of Hot Dip Galvanized Coatings

732.04 DESIGN AND SUBMISSION REQUIREMENTS

732.04.01 Submission Requirements

One copy of the manufacturer's installation instructions and Working Drawings for each type of SBEAT system to be installed shall be submitted to the Contract Administrator.

Installation of the SBEAT system shall not commence until the Contract Administrator has received the copy of the installation instructions and Working Drawings.

732.05 MATERIALS

732.05.01 General

All supplied system components shall be according to the manufacturer's specifications.

732.05.02 U Channel Posts

Posts shall be 2.44 m long perforated steel U channel with 11 mm diameter holes spaced on 50 mm centres, minimum weight of 4.46 kg/m, and hot dip galvanized according to ASTM A 123.

732.07 CONSTRUCTION

732.07.01 General

SBEAT systems shall be installed according to manufacturer's instructions at locations specified in the Contract Documents.

When a SBEAT system is specified in the Contract Documents, the Contractor has the option of using one of the following systems:

a) MASH SoftStop Terminal System

b) MASH Max-Tension Terminal System

c) MASH Sequential Kinking Terminal System

When a specific SBEAT system is specified in the Contract Documents, there shall be no option of substitution for the SBEAT system.

SBEAT systems with steel posts shall be installed to steel beam guide rail systems with steel posts.

SBEAT systems shall be installed according to the manufacturer's instructions at locations specified in the Contract Documents using only the components supplied for a particular SBEAT system unit.

A minimum 2 m wide area behind the posts, measured from the back of the posts shall be clear of all obstacles for the entire length of the SBEAT system.

732.07.02 Posts and Steel Foundation Tubes

All posts and steel foundation tubes shall be set to the depth and alignment at locations specified in the Contract Documents, regardless of the material encountered.

All lower hinge break away posts, steel foundation tubes, and soil plates shall be installed so that no more than 100 mm is exposed above finished grade.

732.07.03 Steel Beam Guide Rails

SBEAT systems shall be connected to new or existing steel beam guide rail as specified in the Contract Documents.

SBEAT system mounting heights shall be measured vertically from the top of the steel beam guide rail to the ground or gutter line. SBEAT system mounting heights shall be within the ranges in Table 1.

Where curb with gutter is required, steel beam guide rail mounting height shall be measured:

a) Vertically at face of steel beam guide rail, when face of steel beam guide rail is more than 300 mm beyond gutter line.

b) Vertically at gutter line, when face of steel beam guide rail is 300 mm or less beyond the gutter line.

Channel shall not be used within the SBEAT system.

732.07.04 Damage to Galvanizing

Precautions shall be taken to protect galvanizing against damage. Minor abrasions shall be repaired according to ASTM A 780. Components with major abrasions shall be replaced.

The method of repair for any damage shall be approved by the Contract Administrator prior to the commencement of such work.

732.07.05 Object Markers and Oversize Plow Markers

A Wa-33 object marker according to OTM Book 6, a Wz-2 oversize snow plow marker, and galvanized mounting hardware shall be installed at each energy attenuator.

When installed on a paved surface, the object marker and oversize snow plow marker shall be integrally attached to a surface mounted flexible post. The signs and post shall be supplied by the manufacturer as a complete unit. The post shall have the ability to bend 90 degrees from vertical and self-restore after impacts. The minimum outside diameter of the post shall be 60 mm. The post shall be anchored to the pavement according to the manufacturer's recommendations.

When installed on a granular surface, the Wa-33 object marker and Wz-2 oversize snow plow marker shall be securely fastened to a U channel post and the post shall be direct buried to a minimum embedment depth of 900 mm.

Posts shall be installed at locations as specified in the Contract Documents.

732.07.06 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

732.09 MEASUREMENT FOR PAYMENT

732.09.01 Actual Measurement

732.09.01.01 Steel Beam Energy Attenuating Terminal System

For measurement purposes, a count shall be made of each complete steel beam energy attenuating terminal system installed, regardless of the type of steel beam energy attenuating terminal system placed.

732.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the unit shown in the clause under Actual Measurement.

732.10 BASIS OF PAYMENT

732.10.01 Steel Beam Energy Attenuating Terminal System - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Costs associated with any required removals and replacement or repairs of defective work and materials shall be the Contractor's responsibility at no additional cost to the Owner.

TABLE 1
SBEAT System Mounting Heights

System	Height During Construction and Seasonal Shutdown mm	Height for Completion of the Work mm
MASH SoftStop Terminal	760 to 810	760 to 810
MASH Max-Tension Terminal	760 to 810	760 to 810
MASH Sequential Kinking Terminal	760 to 810	760 to 810

Appendix 732-A, November 2019
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Steel beam energy attenuating terminal system locations. (732.07.01)

- Depth and alignment of system. (732.07.02)

For Type M steel beam guide rail, use only MASH Terminal Systems.

The steel beam energy attenuating terminal system should be installed flared; however, the system may be installed tangent to the roadway, if grading requirements cannot be met.

The steel beam energy attenuating terminal system should not be installed on roadway with centreline curves less than 250 m radius.

Each steel beam energy attenuating terminal system unit comes from the supplier with all components required for its installation, including posts and steel beam guide rail elements for the length of the system.

Reflective sheeting is normally supplied with each steel beam energy attenuating terminal system. The designer should determine if the sheeting is not required and, if so, specify it in the Contract Documents.

Wherever possible, the designer should eliminate the use of curb with gutter, in advance of and along the length of end treatments and crash cushions. See MTO Roadside Design Manual for additional information.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 202.031	Roadway Widening For Steel Beam Energy Attenuating Terminal, Approach End
OPSD 202.032	Roadway Widening For Steel Beam Energy Attenuating Terminal, Leaving End And Constrained Approach End
OPSD 912.124	Guide Rail System, Steel Beam, Type M Transition Rail, Component
OPSD 912.125	Guide Rail System, Steel Beam, Type M Rail, Component
OPSD 912.127	Guide Rail System, Steel Beam, M20 Steel Post With Offset Block, Component
OPSD 912.130	Guide Rail System, Steel Beam, Steel Post With Offset Block Assembly, Installation - Single Rail
OPSD 912.140	Guide Rail System, Wooden Post Assembly, Installation - Single Rail
OPSD 922.165	Energy Attenuator, End Treatment, Steel Beam Energy Attenuating Terminal, MASH SoftStop Terminal System, Installation
OPSD 922.171	Energy Attenuator, End Treatment, Steel Beam Energy Attenuating Terminal, MASH Max-Tension Terminal System, Installation
OPSD 922.186	Energy Attenuator, End Treatment, Steel Beam Energy Attenuating Terminal, MASH Sequential Kinking Terminal System, Installation

OPSD 984.201	Energy Attenuator, End Treatment, Delineation, Installation - Approach End
OPSD 984.202	Energy Attenuator, End Treatment, Delineation, Installation - Leaving End

CONSTRUCTION SPECIFICATION FOR STEEL BEAM TERMINAL SYSTEM

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733.09 **MEASUREMENT FOR PAYMENT**

733.10 **BASIS OF PAYMENT**

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733-A **Commentary**

733.01 SCOPE

This specification covers the requirements for the installation of steel beam terminal (SBT) systems.

733.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

733.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

733.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Ministry of Transportation Publications

Ontario Traffic Manual (OTM):
Book 6 - Warning Signs

ASTM International

A 123/A 123M-15	Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
A 780/A 780M-09 (2015)	Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings

733.04 DESIGN AND SUBMISSION REQUIREMENTS

733.04.01 Submission Requirements

Installation of the SBT system shall not commence until the Contract Administrator has received one copy of the manufacturer's installation instructions.

733.05 MATERIALS

733.05.01 General

All supplied system components shall be according to the manufacturer's specifications.

733.05.02 U Channel Posts

Posts shall be 2.44 m long perforated steel U channel with 11 mm diameter holes spaced on 50 mm centres, minimum weight of 4.46 kg/m, and hot dip galvanized according to ASTM A 123.

733.07 CONSTRUCTION

733.07.01 General

SBT systems shall be installed according to the manufacturer's instructions at locations specified in the Contract Documents using only the components supplied for a particular steel beam terminal system.

The MASH Slotted Rail Terminal (MSRT) M10 Guardrail End Treatment system shall be used for all SBT installations.

A minimum 2 m wide area behind the posts, measured from the back of the posts, shall be clear of all obstacles for the entire length of the SBT.

733.07.02 Posts and Steel Foundation Tubes

All posts and steel foundation tubes shall be set to the depth and alignment at locations specified in the Contract Documents, regardless of the material encountered.

The lower anchor cable release steel post shall be installed so that no more than 100 mm is exposed above finished grade.

733.07.03 Steel Beam Guide Rails

SBT systems shall be connected to new or existing steel beam guide rail as specified in the Contract Documents.

SBT system mounting heights shall be measured vertically from the top of the steel beam guide rail to the ground. SBT system mounting heights shall be within the ranges in Table 1.

733.07.04 Damage to Galvanizing

Precautions shall be taken to protect galvanizing against damage. Minor abrasions shall be repaired according to ASTM A 780. Components with major abrasions shall be replaced.

The method of repair for any damage shall be approved by the Contract Administrator prior to the commencement of such work.

733.07.05 Object Markers and Oversize Plow Markers

A Wa-33 object marker according to OTM Book 6, a Wz-2 oversize snow plow marker, and galvanized mounting hardware shall be installed at each SBT.

When installed on a granular surface, the Wa-33 object marker and Wz-2 oversize snow plow marker shall be securely fastened to a U channel post and the post shall be direct buried to a minimum embedment depth of 900 mm.

Posts shall be installed at locations as specified in the Contract Documents.

733.07.06 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

733.09 MEASUREMENT FOR PAYMENT

733.09.01 Actual Measurement

733.09.01.01 Steel Beam Terminal System

For measurement purposes, a count shall be made of each complete steel beam terminal system installed, regardless of the type of steel beam end terminal system placed.

733.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the unit shown in the clause under Actual Measurement.

733.10 BASIS OF PAYMENT

733.10.01 Steel Beam Terminal System - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

Costs associated with any required removals and replacement or repairs of defective work and materials shall be the Contractor's responsibility at no additional cost to the Owner.

TABLE 1
Steel Beam Terminal System Mounting Heights

System	Height During Construction and Seasonal Shutdown mm	Height for Completion of the Work mm
MASH Slotted Rail Terminal (MSRT) M10	760 to 810	760 to 810

Appendix 733-A, November 2017
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Steel beam terminal system locations. (733.07.01)

Steel beam terminal (SBT) systems are only installed on horizontal curves with a centreline radius less than 190 m. On curves with a radius greater or equal to 190 m, a steel beam energy attenuating terminal (SBEAT) shall be used.

SBT systems are nominally 14.3 m long, same as SBEAT systems, and contribute nominally 10.0 m tangent to the length of need for steel beam guide rail (SBGR) installations.

SBT's are flared away from the shoulder over the length of installation with the face of post 1 offset 1.2 m from edge of shoulder.

The granular base and earth or rock slopes for the roadway shall be widened to accommodate the terminal in accordance with the appropriate 200 series OPSD.

Where the roadway is being widened for installation of an SBT, ensure that drainage requirements are properly addressed.

Where widening is required and soft ground or muskeg is known or suspected to be present, investigation for widening and subexcavation details will typically be required.

Designers have the flexibility to extend the length of SBGR installations to a location where desirable grading requirements can be accommodated for the SBT.

The area immediately downstream of the approach end of the SBT behind the system should be traversable and clear for a minimum distance of 22 m long by 6 m wide in accordance with appropriate 200 series OPSD.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 202.037	Roadway Widening For Steel Beam Terminal On Inside of Curve
OPSD 202.038	Roadway Widening For Steel Beam Terminal On Outside of Curve
OPSD 922.150	Energy Attenuator, End Terminal, Steel Beam Terminal, MASH Slotted Rail Terminal System, Installation

CONSTRUCTION SPECIFICATION FOR PERMANENT CONCRETE BARRIERS

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740.10 **BASIS OF PAYMENT**

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740-A **Commentary**

740.01 SCOPE

This specification covers the requirements for the construction of permanent concrete barriers.

740.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

740.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

740.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 301 Restoring Unpaved Roadway Surfaces
OPSS 310 Hot Mix Asphalt
OPSS 314 Untreated Subbase, Base, Surface, Shoulder, Selected Subgrade, and Stockpiling
OPSS 501 Compacting
OPSS 904 Concrete Structures
OPSS 919 Formwork and Falsework

Ontario Provincial Standard Specifications, Material

OPSS 1010 Aggregates - Base, Subbase, Select Subgrade, and Backfill Material
OPSS 1150 Hot Mix Asphalt
OPSS 1305 Moisture Vapour Barriers
OPSS 1306 Burlap
OPSS 1308 Joint Filler in Concrete
OPSS 1315 White Pigmented Curing Compounds for Concrete
OPSS 1350 Concrete - Materials and Production
OPSS 1440 Steel Reinforcement for Concrete
OPSS 1442 Epoxy Coated Reinforcing Steel Bars for Concrete

Ontario Ministry of Transportation Publications

Ontario Traffic Manual (OTM):
Book 11 - Pavement, Hazard and Delineation Markings

CSA Standards

G40.20-13/G40.21-13 (R2018)	General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steels
G164-18	Hot Dip Galvanizing of Irregularly Shaped Articles

740.03 DEFINITIONS

For the purpose of this specification, the following definition applies:

Asymmetric means the barrier placed where the pavement elevations on each side of the barrier differ.

740.04 DESIGN AND SUBMISSION REQUIREMENTS

740.04.01 Submission Requirements

A request shall be submitted to the Contract Administrator for permission to use a concrete barrier design other than as specified in the Contract Documents. The request shall be submitted at least 4 weeks prior to starting any work affected by the proposed change.

740.05 MATERIALS

740.05.01 Concrete

Concrete shall be according to OPSS 1350 with a nominal minimum 28-Day compressive strength of 30 MPa, except that tall wall concrete barrier shall have a nominal minimum 28-Day compressive strength of 35 MPa. Coarse aggregate for the concrete shall have a nominal maximum size of 19.0 mm.

All coarse aggregate used for slip-formed tall wall concrete barrier shall have all faces crushed.

740.05.02 Curing

Membrane curing compound shall be according to OPSS 1315. Burlap shall be according to OPSS 1306 and moisture vapour barrier shall according to OPSS 1305.

740.05.03 Joint Filler

Joint filler for permanent concrete barrier shall be according to OPSS 1308.

740.05.04 Formwork

Formwork for permanent concrete barrier shall be according to OPSS 919.

740.05.05 Reinforcing Steel

Steel reinforcement shall be according to OPSS 1440.

Dowel bars shall be according to OPSS 1442.

740.05.06 Asphaltic Concrete

Asphaltic concrete shall be according to OPSS 1150.

740.05.07 Granular

Granular foundation material shall be according to OPSS 1010.

740.05.08 Interlocking Components

Hollow structural steel and wide flange steel sections used in permanent precast concrete barrier shall be according to CSA G40.21, grade 350W, and shall be hot dip galvanized after fabrication according to CSA G164.

740.05.09 Marking

The following information shall be permanently marked on the top or sides of the precast sections:

a) Name or trademark of the manufacturer.

b) Identification of plant if manufacturer has more than one plant.

c) The date of manufacture.

740.07 CONSTRUCTION

740.07.01 Concrete Barrier

Concrete barriers shall be installed at locations as specified in the Contract Documents.

Construction of concrete barrier shall be by the following methods:

a) Conventional wooden or steel formwork.

b) Slip-form.

c) Precast concrete barrier units.

Precast concrete barrier containing the I-Lock connection, may be used in permanent installations. The precast concrete barrier shall be secured in place as specified on the Contract Documents.

740.07.01.01 Foundation Preparation

Preparation of the granular foundation shall be according to OPSS 314 and OPSS 301, as appropriate. Immediately ahead of placing the concrete, the subgrade shall be wet down by means of a uniform spray of water sufficient to wet the subgrade thoroughly without leaving standing water.

Placement of asphaltic concrete pavement beneath and adjacent to the precast concrete barrier shall be according to OPSS 310.

740.07.01.02 Tolerances

Dimensions of the completed barrier shall not deviate by more than 10 mm from the dimensions as specified in the Contract Documents.

The horizontal alignment shall not deviate more than 10 mm from the required lines as specified in the Contract Documents.

When a 3 m long straight edge is placed on the top and faces of the concrete barrier surface, the surface of the concrete shall not vary more than 6 mm from the edge of the straight edge.

When the slip-formed concrete barrier does not conform to the tolerances, the concrete barrier may be corrected to the required tolerances using a magnesium float, while the concrete is still plastic, providing the surface and/or the barrier is not damaged during such adjustments.

740.07.01.03 Surface Finish

The surface of the concrete barrier placed with conventional forms shall have a surface finish according to OPSS 904.

Slip-formed barrier surface shall not be brushed. Offsets and fins shall be removed immediately by light trowelling. Surface blemishes 10 mm or less in diameter shall be left untouched. If surface blemishes larger than 10 mm diameter occur, adjustments in the operation shall be made to correct the condition. If the adjustments do not correct the condition within 10 m, the operation shall be halted until the condition is corrected either by adjustments to the operation or to the concrete mix.

The use of water on the completed barrier to correct imperfections shall not be permitted.

740.07.01.04 Curing

Curing shall be according to OPSS 904 with the exception that white pigmented curing compound is permitted with slip-formed concrete.

Curing for formed surfaces shall be according to OPSS 904.

When joints are made after the application of curing compound, the exposed face of the barrier in the vicinity of the joint shall be retreated with curing compound.

When white pigmented membrane is used as curing compound on slip-formed barrier, it shall also be used on adjacent preformed barrier sections for colour uniformity.

740.07.01.05 Concrete Subject to Cold Weather

Concrete shall not be placed by slip-forming when the ambient air temperature is below 0 °C.

When the concrete is placed at temperatures of 5 °C or less, the concrete in the barrier wall shall be maintained at a minimum temperature of 5 °C for 3 Days. The compressive strength cylinders shall be cast and cured with the barrier wall. The 3-Day compressive strength cylinders shall be at least 80% of the minimum specified 28-Day compressive strength of the wall. If these conditions cannot be met, then the concrete shall be protected according to OPSS 904, for footings and slabs on the ground.

740.07.01.06 Expansion Joints

Expansion joints 12 mm minimum in width shall be installed where concrete barrier abuts a structure, adjacent to piers, over existing deck expansion joints, and at the locations as specified in the Contract Documents. The expansion joint shall be filled with Type A expansion joint filler.

If forming the joint is performed before the concrete has hardened, the adjacent portions of the barrier shall be supported firmly to ensure the design shape of the barrier wall is constructed as specified in the Contract Documents.

740.07.01.07 Construction Joints

Construction joints shall be vertical and square with a rough joint face. Joints shall be created by sawcutting the hardened concrete to a depth of 45 mm ± 5 mm around the outside of the barrier and removing the remaining loose and excess concrete.

Curing compound shall be applied to the joint face.

Transition sections between barrier and treatments for high mast lighting poles, overhead sign structures, and bridge piers in median shall be one-piece construction of the same class of concrete as the barrier. No portion of the transition shall be slip-formed.

Dowels shall only be used at transitions.

Continuity between transition sections and barrier wall sections shall be accomplished by using three size 25M by 1.0 m long, epoxy coated smooth reinforcing bars placed horizontally in the wall. The three bars shall be embedded 500 mm into the squared end of the constructed wall and shall be located on the barrier centre line, commencing 150 mm from the top of the barrier and equally spaced vertically at 150 mm intervals. Construction joints at transition sections for tall wall concrete barrier shall consist of five horizontal epoxy coated smooth reinforcing bars installed.

Prior to constructing the addition, the exposed horizontal bars and the squared end of the barrier wall shall be greased to inhibit bonding.

Transitions for high mast lighting poles and overhead sign structures shall be one-piece construction of the same class of concrete as the barrier wall.

740.07.01.08 Treatment at Bridge Piers

Granular A material with asphalt surface shall be used to fill the area between concrete barriers where separation occurs at bridge piers or at other locations where separation of the barriers is required.

Compaction of granular shall be according to OPSS 501. The asphalt surface shall be according to OPSS 310.

740.07.01.09 Isolation and Contraction Joints

All joints shall be formed in the plastic concrete immediately following the slip-form equipment. Joints shall be formed using a grooving tool with a minimum 40 mm deep bit and shall be continuous along the front and back vertical face, excluding the top of the barrier. Tooling marks or other surface defects adjacent to the newly formed joint shall be trowelled smooth. A proposal may be submitted to sawcut the contraction joints in lieu of scoring, which may be permitted subject to a demonstration of the proposed technique and prior approval by the Contract Administrator.

Isolation joints shall be placed on each side of the outside perimeter of all sub-surface structural elements such as storm-water and maintenance access structures to accommodate vertical differential movement.

Contraction joints shall be equally spaced along the barrier wall at 4 m intervals. This interval may be locally modified to a length between 3 to 5 m to avoid being within 3 m of any other joint.

The construction joint at the end of the day shall coincide with a contraction or isolation joint.

Cracks outside the joints are unacceptable. The section containing the cracks shall be removed and replaced. The limits of removal shall extend to the nearest joint on each side of the crack.

740.07.02 Reflectors

Reflectors placed on permanent concrete barrier shall be according to the OTM Book 11.

740.07.03 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

740.08 QUALITY ASSURANCE

740.08.01 Acceptance Criteria for Precast Concrete Barrier

Final inspection of the precast units will not be made until they have been installed.

All concrete barrier units shall meet the following criteria:

a) There shall be no exposed coarse aggregate, such as honeycombing. The top and bottom surface of the precast unit are excluded from this condition.

b) Cracks shall not extend through the precast unit.

740.09 MEASUREMENT FOR PAYMENT

740.09.01 Actual Measurement

740.09.01.01 Concrete Barrier
Tall Wall Barrier
Asymmetric Concrete Barrier
Asymmetric Tall Wall Barrier

Measurement shall be made in metres along the centreline of the barrier, from end to end of installation, and shall include the length required for lighting pole footings and overhead sign structure footings.

Where two concrete barriers are constructed back to back, Type A-2, TW-2, and M-2; they shall be treated as a single installation and the length will be measured only once for payment purposes.

740.09.01.02 Granular

Measurement shall be according to OPSS 314.

740.09.01.03 Asphaltic Concrete

Measurement shall be according to OPSS 310.

740.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

740.10 BASIS OF PAYMENT

740.10.01 Concrete Barrier - Item
Tall Wall Barrier - Item
Asymmetric Concrete Barrier - Item
Asymmetric Tall Wall Barrier - Item

Payment at the Contract price for the above items shall be full compensation for all labour, Equipment, and Material required to construct the barriers, including any concrete backfill between Type A-2, TW-2, or M-2 concrete barriers at the location of bridge piers or transitions.

Costs associated with any required removals and replacements of defective workmanship or materials shall be the Contractor's responsibility at no cost to the Owner.

740.10.02 Granular

Granular material used as backfill between concrete barriers shall be paid for at the Contract price for the appropriate granular items.

740.10.03 Asphaltic Concrete

Asphaltic concrete laid as a foundation or used as asphalt surface at bridge piers shall be paid for at the Contract price for the appropriate hot mix item.

Appendix 740-A, November 2021
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Location of concrete barriers. (740.07.01)

- Horizontal alignment. (740.07.01.02)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 911.130	Guide Rail System, Concrete Barrier, Cast-In-Place, Type A, Installation
OPSD 911.131	Guide Rail System, Concrete Barrier, Cast-In-Place, Type C, Installation
OPSD 911.132	Guide Rail System, Concrete Barrier, Cast-In-Place, Tall Wall, Installation
OPSD 911.134	Guide Rail System, Concrete Barrier, Installation - Median Concrete Barrier to Structure
OPSD 911.135	Guide Rail System, Concrete Roadside Barrier, Cast-In-Place or Slipformed, Installation
OPSD 911.136	Guide Rail System, Concrete Barrier, Cast-In-Place, Type M, Installation
OPSD 911.143	Guide Rail System, Concrete Barrier, Precast I-Lock Connection, Type TW, Installation - Permanent
OPSD 911.380	Guide Rail System, Concrete Barrier, Permanent Transition, Installation at Piers and Poles
OPSD 911.381	Guide Rail System, Concrete Barrier, Permanent Transition Installation, Roadside Concrete Barrier to Structure
OPSD 911.382	Guide Rail System, Concrete Barrier, Dowel Connection Detail
OPSD 911.383	Guide Rail System, Concrete Barrier, Permanent Transition Installation at Lighting Pole and Sign Support Footings

CONSTRUCTION SPECIFICATION FOR TEMPORARY CONCRETE BARRIERS

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741-A **Commentary**

741.01 SCOPE

This specification covers the requirements for the construction of temporary concrete barriers.

This specification also covers the requirements for installation of restraint systems for temporary concrete barrier, Type M connection only, by the following three methods: pinning to asphalt pavement, strapping to concrete, or bolting through concrete.

741.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

741.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

741.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 723 Energy Attenuators

Ontario Provincial Standard Specifications, Material

OPSS 1350 Concrete - Materials and Production
OPSS 1440 Steel Reinforcement for Concrete
OPSS 1504 Steel Beam Guide Rail
OPSS 1601 Wood, Preservative Treatment, and Shop Fabrication

Ontario Ministry of Transportation Publications

Designated Sources for Materials (DSM)

MTO Form:
PH-CC-876 Certification of Temporary Construction Barrier Installations

Ontario Traffic Manual (OTM):
Book 7 - Temporary Conditions
Book 11 - Pavement, Hazard and Delineation Markings

CSA Standards

G40.20-13/G40.21-13 (R2008)	Rolled or Welded Structural Quality Steel/Structural Quality Steel
W59-18	Welded Steel Construction

ASTM International

A123/A123M-17	Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
D4956-19	Retroreflective Sheeting for Traffic Control

741.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Relocation means the movement of a temporary concrete barrier system from one location to another, which typically occurs when construction operations move from one stage to the next.

Shift means the lateral displacement of a movable temporary concrete barrier system, which is typically completed to facilitate the opening or closing of traffic lane(s). The lateral displacement may vary throughout the length of a barrier installation.

741.04 DESIGN AND SUBMISSION REQUIREMENTS

741.04.01 Submission Requirements

Installation of the movable temporary concrete barrier shall not commence until the Working Drawings and a copy of the manufacturer's specifications and installation instructions have been submitted to the Contract Administrator.

741.05 MATERIALS

741.05.01 Concrete

Concrete shall be according to OPSS 1350, except that the restrictions on volume batching shall not apply. The Contractor shall assume the responsibility for the mix design. The following specific requirements shall apply:

a) Class of concrete: Nominal minimum 28-Day compressive strength of 35 MPa

b) Coarse aggregate: 19.0 mm nominal maximum size

741.05.02 Reinforcing Steel Bars

Reinforcing steel bars shall be according to OPSS 1440 and the Contract Documents.

741.05.03 Connection Assembly Components

Connection assembly components for proprietary temporary concrete barrier systems shall be according to manufacturer's specifications and the Contract Documents.

Connection assembly components for other non-proprietary temporary concrete barrier systems shall be according to the Contract Documents.

741.05.04 Restraint Systems, Type M Connection Only

All materials required for the restraint systems shall be according to the Contract Documents.

741.05.05 Thrie Beam Guide Rails, Bolts, and Nuts

Thrie beam guide rails shall be fabricated according to OPSS 1504 and the Contract Documents. Bolts and nuts shall be according to OPSS 1504.

741.05.06 Steel Plates, Bolts, and Nuts

Steel plates shall be fabricated according to CSA G40.20/G40.21 and the Contract Documents. Steel plates shall have minimum yield strength of 345 MPa. All steel plates shall be hot dip galvanized after fabrication according to ASTM A123. Bolts and nuts shall be according to OPSS 1504.

741.05.07 Wooden Block

Wooden blocks shall be according to OPSS 1601.

741.05.08 Delineators

Delineators shall be two-sided and each side shall have a minimum reflective surface of 100 x 100 mm; high intensity retroreflective sheeting according to ASTM D4956, Type VIII; orange colour; and flexibility to bend 90° from vertical and self restore.

741.05.09 Marking

All temporary concrete barrier units manufactured before March 1, 2008 shall be permanently and legibly marked by the manufacturer on the top or sides of each temporary concrete barrier as follows:

a) Name or trademark of the manufacturer.

b) Identification of plant if manufacturer has more than one plant.

c) The date of manufacture identifying at minimum the year of manufacture with two digits.

d) Markings shall be stencilled in indelible ink, stencilled in paint, or embossed.

All temporary concrete barrier units manufactured on or after March 1, 2008 shall be permanently and legibly marked by the manufacturer on each temporary concrete barrier as follows:

a) Name or trademark of manufacturer on file with Owner including identification of plant if manufacturer has more than one plant and year of manufacture embossed on top of each temporary concrete barrier at one end.

b) Owner approved three digit code of manufacturer and plant identification, and six digit code for date of manufacture (Year Month Day, example January 15, 2008 is 080115) stencilled in minimum 50 mm high digits with indelible ink or paint on top of each temporary concrete barrier at opposite end of embossed markings.

c) Duplicate three digit code of manufacturer and plant identification, and six digit code for date of manufacture, stencilled in minimum 50 mm high digits with indelible ink or paint on the vertical face of one end elevation of each temporary concrete barrier.

d) Markings are not permitted on traffic faces of temporary concrete barrier.

741.06 EQUIPMENT

741.06.01 Barrier Transfer Machine for Movable Temporary Concrete Barrier

Barrier transfer machines required to shift the movable temporary concrete barrier shall be supplied from a source named on the ministry's DSM.

741.07 CONSTRUCTION

741.07.01 Temporary Concrete Barrier

Temporary concrete barrier shall be installed at locations specified in the Contract Documents.

Construction of temporary concrete barrier shall be by use of precast concrete barrier units.

Temporary concrete barrier shall be installed with connections properly engaged.

It is acceptable to transition from one type of temporary concrete barrier to another type of temporary concrete barrier using the temporary concrete barrier transition detail according to the Contract Documents. The proportion of each type of approved temporary concrete barrier used for the Work shall be at the Contractor's discretion. However, a minimum continuous length of 100 m of any one type of temporary concrete barrier is required prior to transitioning to another type.

741.07.01.01 Restrictions on Use of Connections

Contractors shall use temporary concrete barriers with one of the following types of connections:

a) Type J

b) Type M

c) Type T

d) Type X

At locations where restrained temporary concrete barriers are specified in the Contract Documents, temporary concrete barriers with Type M connections shall be used.

At locations where reduced deflection temporary concrete barriers are specified in the Contract Documents, temporary concrete barriers with Type X connections shall be used.

741.07.01.02 Foundation Preparation

Temporary concrete barrier shall be installed on a paved surface having a slope of up to 6% maximum measured perpendicular to the installation. Two Days shall be allowed between the placement of final asphalt surface and placement of temporary concrete barrier. Temporary concrete barrier shall be in place prior to the opening of traffic operations.

Drainage shall be maintained under the temporary concrete barrier.

741.07.01.03 Tolerances

The horizontal and vertical alignment at the junction of each barrier section shall be within 15 mm. The minimum radius on which the barrier may be placed shall be as specified for each type of connection.

741.07.01.04 Construction Markers

Construction markers shall be placed in advance of the temporary precast concrete barrier installation to assist in directing the traffic away from the flared approach end treatment. Taper length for full lane closures and the maximum distance between markers shall be according to OTM Book 7.

741.07.01.05 Quality Control

Temporary precast units shall be certified that they meet the acceptance criteria listed under the Acceptance Criteria for Temporary Precast Concrete Barrier clause. Each installation and relocation of units shall be certified by submitting to the Contract Administrator a completed MTO Form PH-CC-876 within 24 hours of installation or relocation of the units. Units shall be inspected pre- and post-installation. When the installed or relocated units do not meet the acceptance criteria, they shall be removed and replaced with units that meet the acceptance criteria. Certification shall be done by an authorized representative of the Contractor.

While in-service on the Contract and when units have been damaged or alignment discontinuity is beyond that allowable by the acceptance criteria, the affected units shall be reinstalled or replaced as necessary. The repair shall be performed within a 48 hour period, starting at the occurrence or first awareness.

Repaired precast concrete barrier units may be used provided that the structural integrity of the unit is maintained. An Engineer's seal and signature shall be affixed to documentation certifying that the repair method used shall not impact the structural integrity of the unit.

741.07.01.05.01 Acceptance Criteria for Temporary Precast Concrete Barrier

For all applications, any unit that fails one or more of the following acceptance criteria shall be rejected:

a) Dimensions of each unit shall not deviate from those specified by more than the following tolerance:

   i. Specified dimensions up to 300 mm $\pm$ 5 mm
   ii. Specified dimensions greater than 300 mm $\pm$ 10 mm

b) Steel elements of each connecting device shall be free of visible fracture, distortion, and perforation.

c) Concrete within 200 mm of a connecting device shall be free of visible cracks that exceed 0.3 mm in width, measured at the widest point of the crack.

d) All cracks wider than 0.3 mm, other than addressed in c), shall neither extend through the precast unit nor be longer than 300 mm.

e) The unit shall be free of honeycombing.

f) The end of any unit shall not be located further than 50 mm from the horizontal alignment of the installation.

In addition to the above criteria, when the precast units are used on facilities with a posted regulatory speed limit of 80 km/h or higher, any unit that fails one or more of the following acceptance criteria shall be rejected:

a) Damage to edges shall not extend more than 100 mm onto any adjacent face. When edge damage extends more than 50 mm onto such a face, damage to the opposite side of that edge shall not extend more than 50 mm onto the opposite face.

b) The total length of concrete breakout damage to edges flanking the connecting devices, whether repaired or not, shall not exceed 25% of the respective connecting device length on each side of each connecting device.

c) The concrete damage in the area of the drainage recess shall not reach higher than one third of the lower sloped surface containing the recess.

d) Concrete breakouts on the traffic faces or on the top of the precast unit other than addressed in a) to c) above shall not be greater than 150 mm in any direction measured on the surface, nor shall the breakout depth at any point exceed 25 mm measured perpendicularly to the face.

e) Accumulated total concrete breakouts addressed in d) on the traffic sides of the unit shall not exceed 10% of the total surface area of the respective side.

f) Drilled holes into the barrier shall not have diameter greater than 40 mm.

g) The horizontal and vertical alignment discontinuity between adjacent units shall not exceed 20 mm, as measured with a 1 m straightedge.

741.07.02 Drainage Gaps for Temporary Concrete Barrier

Gaps for drainage shall be installed according to the Contract Documents and at locations specified in the Contract Documents.

741.07.03 Temporary Concrete Barrier Restraint Systems, Type M Connection Only

741.07.03.01 General

Type M temporary concrete barrier used for temporary concrete barrier restraint systems shall have been manufactured after October 2011, as verified by the markings.

Restraint systems shall be installed at locations specified in the Contract Documents.

Mechanical and adhesive anchoring systems shall be installed according to the manufacturer's specifications to the minimum embedment depth specified in the Contract Documents.

All welds shall be according to CSA W59.

741.07.03.02 Restoration of Asphalt and Concrete Surfaces

Restoration of asphalt and concrete disturbed during the installation and removal of restrained temporary concrete barrier shall be as specified in the Contract Documents.

741.07.03.03 Transitions

Transitions between restrained temporary concrete barrier and unrestrained temporary concrete barrier shall be as specified in the Contract Documents.

Transitions between unrestrained temporary concrete barrier and permanent concrete barrier shall be as specified in the Contract Documents.

Transitions between reduced deflection temporary concrete barriers and unrestrained temporary concrete barriers shall be as specified in the Contract Documents.

741.07.04 Delineators

Delineators according to OTM Book 11 shall be installed at 4 m intervals.

Delineators shall be securely fastened to the top of the temporary concrete barrier with reflective surfaces clearly visible.

Delineators shall be maintained at all times.

741.07.05 Movable Temporary Concrete Barrier System

The movable temporary concrete barrier system shall be installed and relocated at the locations specified and according to the Contract Documents, the Working Drawings, and the manufacturer's installation instructions and specifications.

Movable temporary concrete barrier shall be installed on a paved surface having a maximum crossfall of 6% measured perpendicular to the installation and shall be in place prior to the opening of traffic operations.

Gaps between barriers shall be kept clear of debris at all times.

The movable temporary concrete barrier system shall be removed from the Working Area when no longer required.

741.07.05.01 Shifting of Movable Temporary Concrete Barrier

The shift of movable temporary concrete barrier, including the shift of energy attenuators, shall be at the locations specified in the Contract Documents. The method and procedure for the shift shall be according to the manufacturer’s installation instructions. The movable temporary concrete barrier and energy attenuators shall be shifted back to the original location when required. Shifting of the movable temporary concrete barrier and energy attenuators at the locations specified in the Contract Documents shall be completed as many times as is necessary to complete the work requiring the shift.

741.07.05.02 End Treatment

One end or both ends, as specified in the Contract Documents, of the movable temporary concrete barrier installation shall be protected with ABSORB 350 energy attenuator according to OPSS 723.

741.07.05.03 Quality Control

Movable temporary concrete barrier units shall be certified that they meet the acceptance criteria listed under the Acceptance Criteria for Movable Temporary Concrete Barrier clause. Every installation and relocation of units shall be certified by submitting to the Contract Administrator a completed Owner Standard Form PH-CC-876 within 24 hours of installation or relocation of the units. Units shall be inspected pre- and post-installation. Certification shall be by an authorized representative of the Contractor.

Installed or relocated units that do not meet the acceptance criteria for movable temporary concrete barrier shall be removed and replaced with units that meet the acceptance criteria within 48 hours.

Units damaged while in service shall be replaced within 48 hours of the damage occurrence or awareness of the damage.

741.07.05.04 Acceptance Criteria for Movable Temporary Concrete Barrier

Any movable temporary concrete barrier unit that fails one or more of the following acceptance criteria shall be rejected:

a) Dimensions of each unit shall not deviate from those specified by more than the following tolerances:

   i. For specified dimensions up to 300 mm, the tolerance shall be ± 5 mm.
   ii. For specified dimensions greater than 300 mm, the tolerance shall be ± 10 mm.

b) Steel elements of each connecting device shall be free of visible fracture, distortion, and perforation.

c) Top or head of each unit shall not expose mesh or rebar nor have damage greater than 75 mm deep.

d) Bottom or foot of each unit shall not have:

   i. Damage greater than 250 mm long measured parallel to roadway.
   ii. Damage greater than 75 mm wide measured perpendicular to roadway.
   iii. Damage greater than 150 mm high.

e) All cracks wider than 0.3 mm shall neither extend through the unit nor be longer than 300 mm.

f) The unit shall be free of honeycombing.

741.07.06 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

741.08 QUALITY ASSURANCE

741.08.01 General

The Owner may conduct random Quality Assurance checks on units that have been supplied and installed or relocated to verify the Contractor's ability to ensure compliance with the acceptance criteria. Units that are identified by the Owner’s representative as not meeting the acceptance criteria or those units that have been repaired and do not have documentation certifying the method of repair must be removed and replaced with units that meet the acceptance criteria for temporary precast concrete barrier. This shall be done within a 48 hour period of notice to the Contractor, unless agreed otherwise in writing.

741.09 MEASUREMENT FOR PAYMENT

741.09.01 Actual Measurement

741.09.01.01 Temporary Concrete Barrier
Temporary Concrete Barrier, Reduced Deflection
Movable Temporary Concrete Barrier

Measurement of barriers shall be by length in metres along the centreline of the barrier, from end to end, including temporary end sections installed and removed, up to the maximum length of barriers required to be placed at any one time during the Contract.

741.09.01.02 Temporary Concrete Barrier, Relocation
Temporary Concrete Barrier, Reduced Deflection, Relocation
Movable Temporary Concrete Barrier, Relocation

Measurement of barriers shall be by length in metres along the centreline of the barrier, from end to end, including temporary end sections relocated.

Barriers that are temporarily surplus, but are required for future stages shall be paid for as one relocation for the combined moves into and out of storage, including any off-site storage required due to on-site restrictions.

741.09.01.03 Temporary Concrete Barrier, Drainage Gap

For measurement purposes, a count shall be made of the number of temporary concrete barrier drainage gaps delivered and accepted.

741.09.01.04 Temporary Concrete Barrier Restraint System, Pinned
Temporary Concrete Barrier Restraint System, Strapped
Temporary Concrete Barrier Restraint System, Bolted

Measurement of barrier restraint systems shall be by length in metres along the centreline of the barrier restraint system, from end to end, installed and removed. Transitions shall be included with the appropriate restraint system.

741.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clause under Actual Measurement.

741.10 BASIS OF PAYMENT

741.10.01 Temporary Concrete Barrier - Item
Temporary Concrete Barrier, Relocation - Item
Temporary Concrete Barrier, Reduced Deflection - Item
Temporary Concrete Barrier, Reduced Deflection, Relocation - Item
Movable Temporary Concrete Barrier - Item
Movable Temporary Concrete Barrier, Relocation - Item
Temporary Concrete Barrier, Drainage Gap - Item
Temporary Concrete Barrier Restraint System, Pinned - Item
Temporary Concrete Barrier Restraint System, Strapped - Item
Temporary Concrete Barrier Restraint System, Bolted - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the Work.

Costs associated with any required removals and replacements of defective workmanship or materials shall be the Contractor's responsibility at no cost to the Owner.

741.10.02 Movable Temporary Concrete Barrier, Shift - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Payment shall be prorated over the time requiring shifting of movable temporary concrete barrier.

Appendix 741-A, November 2021
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Locations where temporary concrete barriers are required. (741.07.01)

- Locations where restrained temporary concrete barriers are required. (741.07.01.01)

- Locations where reduced deflection temporary concrete barriers are required. (741.07.01.01)

- Drainage gap locations. (741.07.02)

- Details should be provided to cover the method and payment for the restoration of asphalt and concrete surfaces that are disturbed during the installation and removal of temporary concrete barrier restraint systems. (741.07.03.02)

- Locations where transitions are required between unrestrained temporary concrete barrier and restrained temporary concrete barrier and between unrestrained temporary concrete barrier and permanent concrete barrier. (741.07.03.03)

- Locations of movable temporary concrete barrier system to be installed and relocated. (741.07.05)

- Locations of movable temporary concrete barrier to be shifted, including the shift of energy attenuators. (741.07.05.01)

- Locations of movable temporary concrete barrier installation to be protected with ABSORB 350 energy attenuators. (741.07.05.02)

The designer should refer to the MTO Roadside Design Manual when installing temporary concrete barrier within 1 m of excavation.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 911.150 to 911.610	Guide Rail System, Temporary Concrete Barrier Drawings
OPSD 924.130	Energy Attenuator, Crash Cushion, ABSORB 350 System, Movable Temporary Concrete Barrier, Installation

CONSTRUCTION SPECIFICATION FOR TEMPORARY TRANSITION BARRIERS

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742.09 **MEASUREMENT FOR PAYMENT**

742.10 **BASIS OF PAYMENT**

APPENDICES

742-A **Commentary**

742.01 SCOPE

This specification covers the requirements for the installation of temporary transition barrier from existing concrete roadside barrier or concrete median barrier to temporary concrete barrier.

742.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

742.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

742.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 906	Structural Steel for Bridges

CSA Standards

G40.20-13/G40.21-13 (R2018)	General Requirements for Rolled of Welded Structural Quality Steel/Structural Quality Steels
G189-66 (R2003)	Sprayed Metal Coatings for Atmospheric Corrosion Protection
W47.1-09 (R2014)	Certification of Companies for Fusion Welding of Steel
W59-18	Welded Steel Construction

ASTM International

A36/A36M-14	Carbon Structural Steel
A123/A123M-17	Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
A143/A143M-07(2014)	Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement
A194/A194M-18	Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both
A500/A500M-18	Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
A563-15	Carbon and Alloy Steel Nuts
A780/A780M-09(2015)	Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings

D4541-17	Test Methods for Pull-Off Strength of Coatings Using Portable Adhesion Testers
F3125/F3125M-18	High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength

The Society for Protective Coatings (SSPC)

SP 8-2004 Pickling

SSPC, American Welding Society (AWS) and NACE Joint Publications

SSPC-CS 23.00/AWS C2.23M/NACE No.12-2003	Application of Thermal Spray Coatings (Metalizing) of Aluminum, Zinc, and Their Alloys and Composites for Corrosion Protection of Steel

742.03 DEFINITIONS

For the purpose of this specification, the following definition applies:

Temporary Transition Barrier means a system that connects temporary concrete barrier to permanent concrete barrier.

742.05 MATERIALS

742.05.01 Steel Components

Steel plates shall be according to CSA G40.21, Grade 300W.

Hollow structural steel sections shall be according to ASTM A500, Grade C.

Bolts shall be according to ASTM F3125. Nuts shall be according to ASTM A563, Grade DH.

Threaded rods and nuts shall be according to ASTM A194, Grade B7 and 2H respectively.

Other steel components not identified above shall be according to ASTM A36.

742.05.02 Hot Dip Galvanizing

Purity of the zinc and the galvanizing bath composition for hot dip galvanizing of railing and metal traffic barrier components shall be according to ASTM A123.

742.07 CONSTRUCTION

742.07.01 Fabrication

742.07.01.01 General

Temporary transition barrier components shall be protected from damage and distortion during hot dip galvanizing, handling, transportation, storage, and installation.

Temporary transition barrier components shall be fabricated according to the Contract Documents.

When welding is required, the fabricator shall be certified according to CSA W47.1, Division 2.1 or better. Welds shall be according to CSA W59.

742.07.01.02 Steel Components

742.07.01.02.01 General

Fabrication and welding shall be according to OPSS 906.

All flame cut edges shall be as smooth and regular as those produced by edge planing and shall be free of slag.

742.07.01.02.02 Surface Preparation for Hot Dip Galvanizing

Prior to galvanizing, temporary transition barrier components shall be cleaned according to SSPC SP 8. The length of time that the components are immersed in the pickling solution shall be kept to an absolute minimum to achieve the specified surface preparation condition prior to hot dip galvanizing. The galvanizer shall employ proper pickling and galvanizing procedures as precautionary measures to safeguard against embrittlement as specified in ASTM A143.

742.07.01.02.03 Hot Dip Galvanizing

Metal components shall be hot dip galvanized according to ASTM A123.

742.07.01.02.04 Repair of Damage to Galvanized Coating

When the galvanized surface of a temporary transition barrier component is damaged or uncoated, the exposed steel shall be repaired if the cumulative total of the damaged and uncoated area does not exceed 2% of the total area of each component or 0.02 m^2, whichever is less. Where the cumulative area exceeds these amounts, the damaged coating shall be stripped and the component re-galvanized according to ASTM A123.

Damaged and uncoated areas shall be cleaned of all rust and other contaminants and repaired using one of the following methods:

a) Soldering Method Using Zinc-Tin-Copper Solder

The surface preparation and application of thermal spray metal coating or metallizing shall be performed according to SSPC-CS 23.00/AWS C2.23M/NACE No.12 to provide a minimum thickness of 200 µm, applied in two separate coats.

The finished thickness of the metal coating in the repaired area shall be a minimum of 90 µm. The repaired surface shall be ground flush with the surrounding galvanized coating.

b) Metallizing

The surface preparation and application of thermal spray metal coating or metallizing shall be performed according to CSA G189 to provide a minimum thickness of 100 µm, applied in two separate coats.

The metal coating on the repaired areas shall have a minimum adhesion of 2.8 MPa, when tested according to ASTM D4541.

c) Zinc-Rich Touch-Up Paint

This method of repair of galvanized coating is permitted when the individual damaged and uncoated area is less than 625 mm^2.

Two coats of zinc-rich touch-up paint shall be brush applied after the surface preparation according to ASTM A 780.

742.07.02 Installation

Installation of temporary transition barriers shall be according to and at locations specified in the Contract Documents.

742.07.03 Relocation

Temporary transition barriers installed on the left side of the roadway may only be relocated to another left side location. Temporary transition barriers installed on the right side of the roadway may only be relocated to another right side location.

742.09 MEASUREMENT FOR PAYMENT

742.09.01 Actual Measurement

742.09.01.01 Temporary Transition Barrier

For measurement purposes, a count shall be made of the number of temporary transition barrier installations.

742.09.01.02 Temporary Transition Barrier Relocation

For measurement purposes, a count shall be made of the number of temporary transition barrier installations relocated.

Barriers that are temporarily surplus and are required for future stages shall be paid for as one relocation for the combined moves into and out of storage, including any off-site storage required due to on-site restrictions.

742.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

742.10 BASIS OF PAYMENT

742.10.01 Temporary Transition Barrier – Item
Temporary Transition Barrier Relocation - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Appendix 742-A, November 2020
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Locations of temporary transition barriers to be installed. (742.07.03)

The temporary transition barrier is a system that provides a crashworthy transition between permanent concrete median barrier or concrete roadside barrier and temporary concrete barrier (TCB). The system meets the crash test acceptance requirements of the AASHTO Manual for Assessing Safety Hardware (MASH) Test Level 3.

The system should be used for transitions where TCB will be in place for a long duration, typically three months or greater, and for transitions where TCB will be in place over a winter season.

When TCB will be in place for short duration, or when relocations are required to accommodate multiple construction stages, temporary energy attenuators should be used.

The first three TCB segments downstream of the temporary steel transition plate shall be Type X and shall be restrained by pinning or bolting as applicable.

When a transition from Type X barrier to a different type of TCB is required, at least one length of unpinned Type X TCB downstream of the pinned Type X TCB shall be provided in advance of the transition.

Where transitions are required for multiple stages, they may be relocated using the relocation item. However, left-side installations may only be relocated to left side locations and right-side installations may only be relocated to right side locations. Quantities of transitions and relocations shall reflect this.

The quantity is based on each completed installation. The first three TCB segments installed as part of the system shall be part of the transition barrier item.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 911.331	Guide Rail System, Concrete Barrier, Temporary Transition Barrier, Installation
OPSD 911.335	Guide Rail System, Concrete Barrier, Temporary Transition Barrier, Ribs and Stiffener Posts - Components
OPSD 911.336	Guide Rail System, Concrete Barrier, Temporary Transition Barrier, Stiffener Post Details - Components
OPSD 911.337	Guide Rail System, Concrete Barrier, Temporary Transition Barrier, Tail Piece - Components
OPSD 911.338	Guide Rail System, Concrete Barrier, Temporary Transition Barrier, End Cap - Components
OPSD 911.339	Guide Rail System, Concrete Barrier, Temporary Transition Barrier, Cup Washer 1 – Component

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OPSD 911.340	Guide Rail System, Concrete Barrier, Temporary Concrete Barrier Transition, Installation - Temporary
OPSD 911.341	Guide Rail System, Concrete Barrier, Temporary Transition Barrier, Connection to Permanent Barrier - Component
OPSD 911.342	Guide Rail System, Concrete Barrier, Temporary Transition Barrier, Cup Washer 2 - Component

CONSTRUCTION SPECIFICATION FOR TEMPORARY TRANSITION CONNECTIONS

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743.08 **QUALITY ASSURANCE - Not Used**

743.09 **MEASUREMENT FOR PAYMENT**

743.10 **BASIS OF PAYMENT**

APPENDICES

743-A **Commentary**

743.01 SCOPE

This specification covers the requirements for the installation of temporary transition connection between temporary concrete barrier and steel beam guide rail.

743.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

743.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

743.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Material

OPSS 1504 Steel Beam Guide Rail
OPSS 1601 Wood, Preservative Treatment, and Shop Fabrication

743.03 DEFINITIONS

For the purpose of this specification, the following definition applies:

Temporary Transition Connection means a system that connects temporary concrete barrier to steel beam guide rail.

743.05 MATERIALS

743.05.01 Steel Beam Guide Rail

Rail, terminal elements, bolts, and nuts shall be according to OPSS 1504.

743.05.02 Wooden Offset Blocks

Wooden offset blocks shall be according to OPSS 1601.

743.05.03 Steel Brackets and Anchors

Steel brackets and anchors shall be as specified in the Contract Documents.

743.05.04 Temporary Concrete Barrier

Temporary concrete barriers shall be as specified in the Contract Documents.

743.07 CONSTRUCTION

743.07.01 General

Temporary transition connections shall be installed as specified in the Contract Documents.

743.07.02 Installation

Installation of temporary transition connections shall be according to and at locations specified in the Contract Documents.

Bolts shall be tightened to 100 Nm. Bolts shall be field cut as required to maintain a maximum protrusion of 12 mm beyond the nut. The cut end of the bolt shall be ground smooth with all sharp edges and burrs removed.

743.07.03 Relocation

Temporary transition connections installed on the right side of the roadway may only be relocated to another right side location. Temporary transition connections installed on the left side of the roadway may only be relocated to another left side location.

743.09 MEASUREMENT FOR PAYMENT

743.09.01 Actual Measurement

743.09.01.01 Temporary Transition Connection

For measurement purposes, a count shall be made of the number of temporary transition connections installed.

743.09.01.02 Temporary Transition Connection, Relocation

For measurement purposes, a count shall be made of the number of temporary transition connections relocated.

Temporary transition connections that are temporarily surplus and are required for future stages shall be paid for as one relocation for the combined moves into and out of storage, including any off-site storage required due to on-site restrictions.

743.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

743.10 BASIS OF PAYMENT

743.10.01 Temporary Transition Connection - Item
Temporary Transition Connection, Relocation - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

Appendix 743-A, November 2020
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Locations of temporary transition connections to be installed. (743.07.02)

- Locations of temporary transition connections to be relocated.

The temporary transition connection is a system that provides a crashworthy transition between temporary concrete barrier (TCB) and permanent or temporary steel beam guide rail. The system meets the crash test acceptance requirements of the AASHTO Manual for Assessing Safety Hardware (MASH) Test Level 3.

Design guidance and a description of this system is provided in the Roadside Design Manual.

The steel posts for the steel beam guide rail system adjacent to the connection shall not be driven through asphalt pavement. Details regarding the minimum area of existing pavement that would have to be removed at each post under the applicable items are detailed on the appropriate OPSD. The two steel beam rails and associated steel brackets immediately adjacent to the connection to TCB are part of the temporary transition connection.

The first five TCBs may be installed on existing granular or paved surfaces as detailed on the appropriate OPSDs. The first four TCBs are part of the temporary transition connection.

Temporary transition connections installed on the right side of the roadway may only be relocated to another right side location. Temporary transition connections installed on the left side of the roadway may only be relocated to another left side location. Quantities of transitions and relocations shall be documented accordingly.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 911.350	Guide Rail System, Concrete Barrier, Steel Beam Guide Rail to Temporary Concrete Barrier, Installation - Temporary
OPSD 911.351	Guide Rail System, Concrete Barrier, Steel Beam Guide Rail to Temporary Concrete Barrier, Connector Plate - Component
OPSD 911.352	Guide Rail System, Concrete Barrier, Steel Beam Guide Rail to Temporary Concrete Barrier, Connector Gussets - Component
OPSD 911.353	Guide Rail System, Concrete Barrier, Steel Beam Guide Rail to Temporary Concrete Barrier, Connector Plate Face Plate - Component
OPSD 911.354	Guide Rail System, Concrete Barrier, Steel Beam Guide Rail to Temporary Concrete Barrier, Steel Brackets - Component
OPSD 911.355	Guide Rail System, Concrete Barrier, Steel Beam Guide Rail to Temporary Concrete Barrier, Wooden Offset Blocks - Components

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OPSD 911.357	Guide Rail System, Concrete Barrier, Steel Beam Guide Rail to Temporary Concrete Barrier, Temporary Transition Connection
OPSD 912.313	Guide Rail System, Steel Beam, Transition From Type M to Existing Steel Beam Guide Rail - Installation

CONSTRUCTION SPECIFICATION FOR CONNECTICUT IMPACT ATTENUATION SYSTEM (CIAS)

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753.08 **QUALITY ASSURANCE - Not Used**

753.09 **MEASUREMENT FOR PAYMENT**

753.10 **BASIS OF PAYMENT**

APPENDICES

753-A **Commentary**

753.01 SCOPE

This specification covers the requirements for the installation of Connecticut Impact Attenuation Systems (CIAS).

753.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

753.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

753.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 314	Untreated Granular, Subbase, Base, Surface, Shoulder, and Stockpiling
OPSS 904	Concrete Structures

Ontario Provincial Standard Specifications, Material

OPSS 1010	Aggregates - Base, Subbase, Select Subgrade, and Backfill Material
OPSS 1350	Concrete - Materials and Production
OPSS 1440	Steel Reinforcement for Concrete

CSA Standards

G40.20-13/G40.21-13 (R2018)	Rolled or Welded Structural Quality Steel / Structural Quality Steel
W47.1-19	Certification of Companies for Fusion Welding of Steel
W59-18	Welded Steel Construction

ASTM International

A53/A53M-20	Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
A123/A123M-17	Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
A153/A153M-16a	Zinc Coating (Hot-Dip) on Iron and Steel Hardware
A307-14e1	Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength

753.05 MATERIALS

753.05.01 Concrete

Concrete shall be according to OPSS 1350 with a nominal minimum 28-Day compressive strength of 30 MPa.

753.05.02 Granular Base

Granular base shall be Granular A according to OPSS 1010.

753.05.03 Reinforcing Steel Bars

Reinforcing steel bars for concrete backwall shall be according to OPSS 1440.

753.05.04 Fasteners

Bolts, nuts, washers, and spacers shall be according to ASTM A307 and hot dip galvanized according to ASTM A153.

753.05.05 Steel Cylinders

Cylinders shall be fabricated from steel according to CSA G40.21, Grade 300W, and hot dip galvanized after fabrication to provide a zinc coating not less than 610 g/m^2 according to ASTM A123.

Cylinders shall be cut square and seamless or electric welded. The finished cylinder shall be within 15 mm of true round. Each cylinder shall be labelled at the top with the designated A to N alphabetical character.

All edges shall be machined and free of burrs and sharp edges.

753.05.06 Steel Rails

Steel rails shall be fabricated as specified in the Contract Documents from flat stock steel according to CSA G40.21, Grade 300W, and hot dip galvanized after fabrication to provide a zinc coating not less than 610 g/m^2 according to ASTM A123.

753.05.07 Steel Straps, Lid Support Angles, and Lifting Devices

Steel straps, lid support angles, and lifting devices shall be steel according to CSA G40.21, Grade 300W. All straps shall be cut to the width and length and welded to the cylinder as specified in the Contract Documents.

753.05.08 Steel Pipes

Steel pipes shall be 48.3 mm OD, standard weight, Schedule 40 steel pipe according to ASTM A53 and welded to one side of the cylinder as specified in the Contract Documents.

753.05.09 Steel Pipe Retainers

Steel pipe retainers shall be 50 mm by 32 mm OD, standard weight, Schedule 40 steel pipe according to ASTM A53 and welded to the side of the cylinder as specified in the Contract Documents.

753.05.10 Lids

Lids shall be fabricated from low-density polyethylene composed of 25% recycled plastic materials. Lids shall be black in colour and UV stabilized to a minimum rating of UV8D. The lid shall be of sufficient strength to support a centred point load having a mass of 60 kg producing a maximum deflection of 100 mm.

Each lid shall have a steel restraining chain for attachment of the lid to the cylinder.

Associated metal hardware for the lids, such as washers, eye bolts, chains, and screws shall be hot dip galvanized according to ASTM A153 or equivalent electroplated or anodized treated.

753.05.11 Welds

All welding shall be according to CSA W47.1 and CSA W59.

753.07 CONSTRUCTION

753.07.01 General

Connecticut Impact Attenuation Systems shall be installed according to and at locations specified in the Contract Documents.

753.07.02 Concrete Pads and Backwalls

Levelling and site preparation required for the existing granular base shall be performed prior to placing the concrete pad and backwall.

Concrete pads and backwalls shall be constructed as specified in the Contract Documents. Concrete shall be placed, cured, and finished according to OPSS 904. Cross fall of the concrete pad is desirably 6% or less and shall not exceed 10%. All exposed edges of the backwall shall have a 25 mm chamfer. Drilling of anchor holes shall commence a minimum of five days after concrete has been placed.

753.07.03 Granular Base

The granular base below the concrete pad shall be a minimum depth of 150 mm and shall be placed according to OPSS 314. The granular material shall be compacted to 95% of the maximum dry density.

753.07.04 Connection to Barriers

The concrete backwall shall be connected to the barrier as specified in the Contract Documents.

753.07.05 Delineation

Delineation shall be provided as specified in the Contract Documents.

753.07.06 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

753.09 MEASUREMENT FOR PAYMENT

753.09.01 Actual Measurement

753.09.01.01 Connecticut Impact Attenuation System

For measurement purposes, a count shall be made of the number of complete Connecticut Impact Attenuation Systems installed.

753.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

753.10 BASIS OF PAYMENT

753.10.01 Connecticut Impact Attenuation System - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

Costs associated with any required removals and replacement or repairs of defective work and materials shall be the Contractor's responsibility at no additional cost to the Owner.

Appendix 753-A, November 2021
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Connecticut Impact Attenuation System locations. (753.07.01)

The designer should determine to which standard Connecticut Impact Attenuation Systems should be installed and specify it in the Contract Documents:

a) The Connecticut Impact Attenuation System should only be installed at a 10° skew to the centreline of the roadway when the length of the median hazard and the median width can accommodate a Connecticut Impact Attenuation System at each end of the hazard within the limits specified in OPSD 923.245. In this case, the designer should specify that the system be installed according to OPSD 923.245.

b) The Connecticut Impact Attenuation System should only be installed at a 0° skew to the centreline of the roadway when the length of the median hazard is too long and the median width is too narrow to accommodate a Connecticut Impact Attenuation System at each end of the hazard within the limits specified in OPSD 923.245. In this case, the designer should specify that the system be installed according to OPSD 923.244.

The designer should specify the barrier system to be used between Connecticut Impact Attenuation Systems placed back to back shielding a median hazard.

Wherever possible, the designer should eliminate the use of curb with gutter, in advance of and along the length of end treatments and crash cushions. See the MTO Roadside Safety Manual for additional information.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 923.201	Energy Attenuator, Crash Cushion, Connecticut Impact Attenuation System, Component - Steel Cylinder
OPSD 923.202	Energy Attenuator, Crash Cushion, Connecticut Impact Attenuation System, Component - Polyethylene Lid
OPSD 923.204	Energy Attenuator, Crash Cushion, Connecticut Impact Attenuation System, Component - Concrete Backwall
OPSD 923.242	Energy Attenuator, Crash Cushion, Connecticut Impact Attenuation System, Installation
OPSD 923.244	Energy Attenuator, Crash Cushion, Connecticut Impact Attenuation System, Installation - Long Median Hazard
OPSD 923.245	Energy Attenuator, Crash Cushion, Connecticut Impact Attenuation System, Installation - Short Median Hazard
OPSD 984.205	Energy Attenuator, Crash Cushion, Connecticut Impact Attenuation System, Delineation, Installation - Permanent

CONSTRUCTION SPECIFICATION FOR NOISE BARRIER SYSTEMS

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760-A **Commentary**

760.01 SCOPE

This specification covers the requirements for the installation of noise barrier systems.

760.01.01 Specification Significance and Use

This specification has been developed for use in municipal-oriented Contracts. The administration, testing, and payment policies, procedures, and practices reflected in this specification correspond to those used by many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

760.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

760.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 206	Grading
OPSS 501	Compacting
OPSS 510	Removal
OPSS 609	Grounding
OPSS 904	Concrete Structures
OPSS 906	Structural Steel for Bridges

Ontario Provincial Standard Specifications, Material

OPSS 1350	Concrete - Materials and Production
OPSS 1440	Steel Reinforcement for Concrete

CSA Standards

S6-06	Canadian Highway Bridge Design Code

ASTM International

A 123/A 123M-17	Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
A 780/ A 780M-09(2015)	Repair of Damaged and Uncoated Areas of Hot Dip Galvanized Coatings
B 209-14	Aluminum and Aluminum-Alloy Sheet and Plate

760.03 DEFINITIONS

For the purpose of this specification, the following definition apply:

Manufacturer means the party that supplies and/or specifies the design, materials, and components for the proprietary noise barrier system selected by the Contractor.

760.04 DESIGN AND SUBMISSION REQUIREMENTS

760.04.01 Design Requirements

Noise barrier system design shall be as specified in the Contract Documents and according to the manufacturer's specifications.

760.04.01.01 Footings

760.04.01.01.01 General

Depth of footings shall be according to CAN/CSA S6 and based on the soil design parameters and wind load as specified in the Contract Documents.

760.04.01.01.02 Footings in Earth

When footings are to be installed on or within 1 m from a downward slope of 3H:1V or steeper, the Working Drawings shall reflect this and shall note an increase in embedment depth of a minimum of 0.5 m greater than the requirements specified in CAN/CSA S6.

760.04.01.01.03 Footing in Rock

When rock is encountered within the specified excavation depth for footings in earth, the footing shall be designed and constructed according to the Footings in Earth clause based on soil properties and wind load as specified in the Contract Documents. Alternatively, the design depth into rock shall be designed based on rock properties provided by the Owner. The minimum design depth below final grade shall not be less than 1.5 m or to the frost depth, whichever is the greater.

760.04.02 Submission Requirements

760.04.02.01 Working Drawings

The Contractor shall submit 3 copies of Working Drawings for the noise barrier system to the Contract Administrator at least 4 weeks prior to the commencement of construction. The Working Drawings shall show full details of noise barrier related items, erection procedures and, if applicable, connections to structures. An Engineer's seal and signature shall be affixed on the Working Drawings verifying that the drawings are consistent with the Contract Documents.

760.05 MATERIALS

760.05.01 General

All components for noise barrier systems shall be according to the manufacturer's specifications and as specified in the Contract Documents.

760.05.02 Granular Materials

Granular material shall be as specified in the Contract Documents.

760.05.03 Footings

Cast-in-place concrete in footings shall be according to OPSS 1350 with a nominal minimum 28-Day compressive strength of 30 MPa.

760.05.04 Steel Reinforcement

Steel reinforcement for the footings shall be according to OPSS 1440.

760.07 CONSTRUCTION

760.07.01 General

Noise barrier systems shall be installed according to manufacturer's specifications at locations specified in the Contract Documents.

760.07.02 Site Grading and Preparation

Grading and berm construction associated with the barrier installation shall be completed to within 25 mm below the bottom of the barrier prior to constructing the barrier footings. Grading up to 300 mm shall be part of installation of noise barrier system.

All grading shall be according to OPSS 206.

Earth and granular materials shall be compacted according to OPSS 501.

There shall be no visible gaps between any barrier panels or beneath the bottom panels after completion of the barrier.

Tree pruning and removal shall be kept to a minimum and shall be subject to the approval of the Contract Administrator prior to the commencement of any pruning and removal.

760.07.03 Footings

Concrete shall be according to OPSS 904.

Concrete for drilled footings shall be cast entirely against undisturbed soil.

For other footings, the footing shall be formed and the excavation shall be backfilled with granular materials and compacted to at least 95% standard Proctor maximum dry density.

When required, the top of all footings shall be shaped to provide for full horizontal seating of panels and the remaining surface area shall be sloped away from the post to shed water. Stepped footings shall be constructed to suit grade changes.

Concrete in the footings shall be cured to meet design strength as specified by the Engineer prior to the installation of noise barrier panels.

All excavations into rock shall be backfilled entirely with concrete. Excavation above the top of rock shall be formed to the required dimensions and the remainder of the excavation backfilled with granular material.

760.07.04 Posts

Structural steel posts shall be according to OPSS 906.

Steel posts and components shall be hot dip galvanized after fabrication according to ASTM A 123. Galvanized surfaces that are abraded shall be cleaned and painted with a zinc-rich paint according to ASTM A 780.

The top of footing and underside of post base plate shall be filled with non-shrink grout according to the manufacturer's specifications.

Tolerance for post plumb shall be according to the manufacturer's specifications.

760.07.05 Panels

Panels shall be installed horizontally and stepped when necessary to match the elevation profile specified on the Working Drawings. Changes in horizontal direction shall be made using special arrangements of the posts according to the manufacturer's specifications.

All panels shall be cleaned of any oils, dirt, and debris.

760.07.06 Noise Barriers on Structures

Noise barrier system shall be attached to the structure as specified in the Contract Documents.

Flashing shall be installed and sealed in a manner so that water will not pond on the structure according to the manufacturer's specifications.

760.07.07 Precast Noise and Traffic Barriers

Precast noise or traffic barrier units or both shall be constructed to the line and grades as specified in the Contract Documents with a tolerance of ±10 mm.

When changes in horizontal alignment are greater than 2° or when changes in vertical alignment are greater than 2% between adjacent units occur, the ends of the units shall be manufactured with the appropriate skewed end detail. Units required to match ground profiles with grades in excess of 2% shall be manufactured with skewed ends to match the vertical post detail. The space between each unit on the traffic side surface shall not exceed 25 mm at the base of the traffic barrier. The difference in elevation between adjacent units shall not exceed 25 mm. Any levelling or plumbing of units shall be done according to the manufacturer's specifications.

Granular base for the precast noise or traffic barrier units or both shall be placed in a manner to ensure that there are no voids between the bottom surface of units and the granular material and that the units are set to the correct line and grades.

Precast noise or traffic barrier units or both shall be set according to the manufacturer's specifications. Top of footings shall be clear of foreign material, ice, snow, or water.

Precast noise or traffic barrier units or both shall be positioned to have complete contact with the post flange along the traffic side of the units.

Top of the noise or traffic barrier units or both shall be cleared of any foreign or loose material, ice, snow, or water prior to installing the noise barrier panels.

The point of contact between the top of the precast noise or traffic unit or both and the bottom of the noise barrier panels shall be sealed according to manufacturer's specifications.

760.07.08 Noise Barrier Access Openings

Openings, frames, doors, and hardware for noise barrier access shall be supplied and installed in accordance with the manufacturer's Working Drawings and installation instructions at the locations and of the types specified in the Contract Documents.

Openings shall be cut a minimum distance of 1.0 m from the centerline of the noise barrier post to the centerline of the opening.

The centre of fire hose access openings shall be located within the range of 1.3 to 1.5 m measured from the finished ground surface.

Standard opening sizes for fire hose access and person door access are shown in Table 1. Dimensions and details for all other access opening types including, but not limited to electrical access, vehicle access, and hydraulic access are as specified in the Contract Documents. The openings shall meet the specified dimensions and shall be centred between adjacent posts.

Each noise barrier access opening shall be fitted with a hinged door that opens away from the roadway to a minimum opening angle of 110º.

When doors are in the closed position, there shall be no impact to the acoustical characteristics of the noise barrier system. All gaps between openings and frames shall be sealed to ensure that there are no gaps.

760.07.09 Connection to Existing Fence

When sections of an existing parallel or cross fence are to be removed or replaced or both with a noise barrier system, the Contractor shall ensure that a sufficient length of existing fence is maintained in good condition to adequately allow for connection to a new post at locations shown in the Contract Documents.

Removal of any fence shall be according to OPSS 510.

760.07.10 Underground Utility and Drainage Crossings

Reduced post spacing shall be allowed according to the manufacturer's specifications to avoid placing posts on top of utilities and drainage facilities.

760.07.11 Existing Overhead High Voltage Lines

When the potential of arcing exists due to the close proximity of existing overhead high voltage lines, steel noise barrier panels and posts shall be grounded according to OPSS 609.

760.07.12 Marking

Identification plates, provided by the manufacturer, shall be attached to the completed noise barrier system at the following intervals:

a) At the start and end of noise barrier system.

b) At a maximum interval of 300 m.

The identification plate shall be located within 300 mm of a terminal post with the top of the plate located approximately 1.2 m above the ground. The maximum dimensions of the plate shall be 200 by 200 mm. The plate shall be made from 0.81 mm thick anodized aluminum sheet according to ASTM B 209 series 1100 or 5005-H34.

Each plate shall be engraved with the following information:

a) Contract number.

b) Name of manufacturer of noise barrier system.

c) Name of Subcontractor that installed the noise barrier system.

d) Date of completed installation (i.e., yyyy-mm).

The height of the letters and numerals shall be within the range of 6 to 32 mm.

760.07.13 Quality Control

760.07.13.01 Interim Inspection of Footings and Posts

During construction of the noise barrier footings and posts and prior to the installation of the noise barrier panels from the fabrication facility, the Contract Administrator shall conduct an inspection during the work to verify that the footings and posts have been constructed in general conformance with the Contract Documents and issue the Contractor written permission to proceed with the work.

760.07.14 Site Restoration

After noise barrier system installation, the site shall be cleaned and trimmed and the ground restored to a neat condition.

760.07.15 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

760.08 QUALITY ASSURANCE

760.08.01 Construction

Noise barrier components damaged in transit or during placement shall be replaced by the Contractor at no cost to the Owner.

The Contractor shall install noise barrier materials that are visually uniform in appearance in terms of colour, pattern, and texture. Uniformity of appearance is subject to approval of the Contract Administrator. Noise barrier panels shall visually match adjacent panels. Inspection shall occur at a distance of approximately 15 metres from the noise barrier system.

Final inspection of the complete noise barrier system shall not be made until it has been installed.

760.09 MEASUREMENT FOR PAYMENT

760.09.01 Actual Measurement

760.09.01.01 Noise Barrier System
Noise Barrier System Including Precast Noise/Traffic Barrier
Noise Barrier System on Structures

Measurement of noise barrier system shall be along the horizontal length in metres of the specified height. Transitions between barrier heights shall form part of the higher barrier and terminations shall form part of the adjoining barrier.

At the discretion of the Contract Administrator, if unidentified difficult soil conditions (i.e., rock, shale, or unstable earth) are encountered above the design footing depths, work necessary to complete the design requirements such as caissons, dewatering, additional concrete, or different augering equipment, shall be paid for as Additional Work.

760.09.01.02 Noise Barrier Access

For measurement purposes, a count shall be made of the number of accesses installed.

760.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

760.10 BASIS OF PAYMENT

760.10.01 *"height"* Noise Barrier System - Item
***"height"* Noise Barrier System Including Precast Noise/Traffic Barrier - Item**
***"height"* Noise Barrier System on Structures - Item**
Noise Barrier Access - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Grading up to 300 mm shall be included as part of the noise barrier system item. For earth grading requirements greater than 300 mm, the full grading is provided under the earth excavation item.

760.10.02 Removals and Replacements

Cost associated with any required removals and replacements of defective workmanship or materials shall be the Contractor's responsibility at no cost to the Owner.

TABLE 1
Noise Barrier Access Standard Opening Sizes

Type of Door / Opening	Opening Size (W mm x H mm)
Fire Hose Access	254 x 254
Person Door Access	915 x 2438

Appendix 760-A, April 2019
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Noise barrier system design requirements should include the following: (760.04.01)

a) Acoustics

The noise barrier system shall be designed for one of the following acoustical characteristic:

i. Either sound absorptive or reflective
ii. Sound absorptive on the highway side
iii. Sound absorptive on the residential side
iv. Sound absorptive on both sides.

If more than one acoustical characteristic apply to this Contract for various sections, then each section shall be designed accordingly with clearly defined limits.

b) Height

The designer shall select an appropriate height according to the acoustical requirements, which shall not be more than 5 metres.

c) Aesthetics

The designer shall plan the number of colours and textures for the Contract. The designer shall also specify the patterns and proportions in which each is required. The exact colour, texture, and pattern for the noise barrier system shall be specified following the award of the Contract, but will be within the following parameters:

The number of colours adjacent to highway is _____;

in the proportion of: _____ _____ _____ _____

The number of textures is _____;

in the proportion of: _____ _____ _____ _____

The number of colours adjacent to residential property is _____;

in the proportion of: _____ _____ _____ _____

The number of textures is: _____;

in the proportion of: _____ _____ _____ _____

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Final colour selections shall be determined by the Contract Administrator at the point of manufacture from samples prepared by the manufacturer.

If only one colour and texture are to be used, the noise barrier shall be constructed using only one colour and texture, which shall be specified by the Contract Administrator following the award of the Contract. Final colour selection shall be determined at the point of manufacture from samples prepared by the manufacturer.

d) Noise Barrier Access

The designer should provide station and offset (Lt. or Rt.) locations for all required barrier access points and indicate the type of access opening required at each location. Opening sizes for fire hose access and person access are standard. Opening sizes for other types of access including, but not limited to electrical access, vehicle access, and hydraulic access are site specific and should be specified by location and opening size.

- Soil design parameters and wind loads for footings should include the following: (760.04.01.01.01)

a) Footings

The designer shall design the noise barrier system footings according to CAN/CSA S6 with the assistance of soil design parameters. The designer shall also provide the soil design parameters as per the example below.

Station to Station	Soil Design Parameter
<u>East Bound Lane</u> 17+320 to 17+790 (shoulder)	Ø = 28º
<u>West Bound Lanes</u> 17+100 to 17+600 (ROW) 17+600 to 17+720 (ROW) 17+700 to 18+050 (shoulder)	Ø = 28º Cu = 12 Kpa Ø = 28º

b) Wind Pressure

The wind pressure information shall be used from CAN/CSA S6 for the city where the project is located (e.g., 415 Pa for Hamilton area).

- Noise barrier system material requirements. (760.05.01)

- Granular material to be used. (760.05.02)

- Noise barrier system locations. (760.07.01)

- Attachment requirements for noise barrier system to structure. (760.07.06)

- Line and grade specifications for precast noise/traffic barrier units. (760.07.07)

- Noise barrier access opening requirements. (760.07.08)

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- Locations where noise barrier system connects to existing fence. (760.07.09)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

CONSTRUCTION SPECIFICATION FOR STANDARD HIGHWAY FENCE

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771-A **Commentary**

771.01 SCOPE

This specification covers the requirements for the installation of highway fence, brace panels, and gates.

771.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

771.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

771.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 510 Removal

Ontario Provincial Standard Specifications, Material

OPSS 1540 Standard Highway Fence Components

ASTM International

A780/A780M-20 Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings

B209/B209M-21 Aluminum Alloy Sheet and Plate

771.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Corner Post means the terminal post installed at horizontal deflections in the fence line greater than 22 degrees.

Cross Fences means intersecting wire fences.

Line Post means the fence post spaced at regular intervals between terminal posts throughout each section of fence.

Line Wire means the horizontal wire of the fence fabric.

Stay Wire means the vertical wire that is woven or wrapped around the line wire to form the rectangular opening of the fence fabric.

Straining Post means the terminal post installed at changes in vertical deflections in the fence line greater than 22 degrees or at approximately 200 m intervals.

Terminal Post means end, gate, corner, and straining posts.

Twitch-Stick Method means the tensioning of wires by inserting and rotating a twitch stick between the space of the diagonal wires as they cross.

771.05 MATERIALS

771.05.01 Highway Fence

Highway fence components shall be according to OPSS 1540.

771.05.02 Fence Fabric

Only one type of fence fabric shall be used within the limits of the Contract.

771.07 CONSTRUCTION

771.07.01 Removal

Removal of existing fence shall be according to OPSS 510.

771.07.02 Site Preparation

Prior to the commencement of fencing operations, all debris shall be removed and ground undulations shall be corrected along the fence line to obtain a smooth and uniform gradient.

All trees, stumps, and brush along the fence line shall be cut off at ground level and all logs and overhanging branches that interfere with the installation of the fence shall be removed.

771.07.02.01 Selective Clearing

When fencing is required through wooded areas that are not designated for clearing and grubbing, only selective clearing shall be permitted in order to gain access to the fence line and to permit fence installation with lightweight equipment. Clearing shall be kept to a minimum and shall be subject to the approval of the Contract Administrator prior to the commencement of any clearing operation. Additional clearing may be required to travel around obstructions.

The location of access points shall be based on the least amount of clearing required and the frequency of access points shall be subject to reasonable material delivery requirements. The access points shall be approved by the Contract Administrator.

771.07.03 Highway Fence

771.07.03.01 General

Highway fence shall be installed at locations as specified in the Contract Documents.

Survey reference points or permanent property boundary markers shall not be disturbed or moved without the authorization of the Contract Administrator. When it is necessary to set posts adjacent to such points, the posts shall be placed on the roadway side of the property line as close as feasible to the monuments or markers.

771.07.03.02 Post Installation

771.07.03.02.01 General

All posts shall be installed plumb and to the depth as specified in the Contract Documents.

Terminal posts shall be installed at all highway fence ends, both sides of all openings and gates, locations with changes in horizontal or vertical deflections greater than 22 degrees in the fence line, and at locations identified for straining purposes. Terminal posts shall be installed on each side of watercourse crossings. Line posts shall be installed as specified in the Contract Documents.

771.07.03.02.02 Post Installation in Earth, Shale, or Loose or Friable Rock

Postholes for wooden posts shall be excavated to 150 mm greater that the diameter of the larger end of the post. The large end of the post shall be placed in the bottom of the posthole. Material resulting from posthole excavation shall be used as backfill around the posts and compacted to 90% modified proctor density.

Steel posts shall be driven with care to ensure they will not be bent or burred.

771.07.03.02.03 Post Installation in Rock

Posts installed in solid rock shall be steel posts as specified in the Contract Documents.

Postholes for steel posts shall be drilled in rock to a maximum diameter of 150 mm. Overburden shall be excavated to a maximum diameter of 300 mm. Posts shall be placed in the postholes and filled as specified in the Contract Documents.

771.07.03.03 Brace Panels

Brace panels shall include the installation of the diagonal wooden braces or diagonal angle iron braces; diagonal brace wires; and fasteners, as appropriate.

Diagonal brace wires may be tensioned using the twitch-stick method.

When cross fence separates property owners, three brace panels shall be installed at the end post of cross fences. When the cross fence does not separate property owners, one brace panel shall be installed on the cross fence at the end post.

Brace panels at straining posts shall be installed at equal intervals of approximately 200 m without any intervals greater than 230 m. Brace panels shall be installed on each side of a corner, straining, opening, or gate locations.

Brace panels shall be installed at terminal posts on each side of watercourse crossings.

When fences are to be partially removed, brace panels shall be installed at the terminal ends of the remaining fence.

771.07.03.04 Fence Fabric

Fence fabric shall be placed on the side of the post nearest the roadway, except on curves with a radius of less than or equal to 1,750 m. In this situation, the fabric shall be placed on the side of the post away from the centre of the curve.

Fence fabric shall be uniformly tensioned so that its line wires are tight and parallel and the stay wires are straight, uniformly spaced, and at right angles to the line wires.

Staples for fence fabric with design numbers 949-12-9 and 948-12-9.75 shall be set diagonally to the grain of the wooden post and driven securely. Top wire shall be double stapled and all other wires single stapled.

Staples for fence fabric with design number 949-12-12.5 shall be set diagonally to the grain of the wooden post and driven securely, but shall allow for movement of the horizontal line wires as a result of thermal expansion and contraction.

Fence fabric shall be fastened to the steel post using wire ties at all nine line wires.

Fencing fabric shall be tensioned and properly terminated with the wire wrapped around the terminal posts at least once and around itself at least four complete turns and stapled to the terminal posts.

Rolls of fence fabric with design numbers 949-12-9 and 948-12-9.75 shall be spliced together by wrapping adjacent line wires using mechanical splicing units or using crimp sleeves. The same method shall be used throughout the limits of the Contract.

Rolls of fence fabric with design number 949-12-12.5 shall be spliced together using mechanical splicing units or crimp sleeves.

When splicing is achieved by wrapping adjacent line wires, wrap the overhanging line wires around the corresponding line wires on the adjacent roll, at least four complete turns as specified in the Contract Documents.

Mechanical splicing units and crimp sleeves shall be installed according to the manufacturer’s instructions and as specified in the Contract Documents.

After splicing, all projecting ends of the line wires shall be removed. Terminal posts shall not be installed for splice purposes only.

771.07.04 Cross Fences

Cross fences shall be secured to the adjacent post prior to cutting the fence at the brace panel.

771.07.05 Gates

Gates shall be installed at locations and be of the type and size as specified in the Contract Documents.

When gates are required without adjacent fencing, terminal posts with brace panels shall be installed on each side of the gate.

Gates shall be installed to open away from the roadway and to close by gravity.

771.07.06 Marking

Identification plates provided by the material supplier shall be securely attached to the completed fence installation at the following intervals:

a) At the start and end of each fence installation.

b) At a maximum interval of 300 m.

The fence identification plate shall be located within 300 mm of a terminal post with the top of the plate located approximately 300 mm from the top of the fence fabric. The maximum dimensions of the plate shall be 200 by 200 mm. The plate shall be made from 0.81 mm thick anodized aluminum sheet according to ASTM B209M series 1100 or 5005-H34.

Each fence identification plate shall be engraved with the following information:

a) Contract number.

b) Name or trademark of fence Subcontractor.

c) Name or trademark of fence supplier (i.e., suppliers of fence fabric and posts).

d) Date of completed installation (i.e., yyyy-mm).

The height of the letters and numerals shall be within the range of 6 to 32 mm.

771.07.07 Zinc Coating Repairs

Cut ends, field drilled holes, and damaged areas of hot dip galvanized coatings on galvanized components, except fence fabric, shall be repaired according to ASTM A780M.

771.07.08 Site Restoration

After fence installation, the site shall be cleaned and trimmed and the ground restored to a neat condition.

771.07.09 Management of Excess Material

Management of excess material shall be as specified in the Contract Documents.

771.08 QUALITY ASSURANCE

771.08.01 Construction

The Contract Administrator may perform a spot visual inspection to determine conformance with the workmanship, design, and dimensional requirements of this specification.

Failure to conform to this specification may result in a partial or complete inspection of the installation by the Contract Administrator and removal and replacement of all defective workmanship or materials by the Contractor.

771.08.02 Material Certification

Certificates of compliance for each fence component used in the installation shall be provided to the Contract Administrator. The certificate of compliance shall indicate that the material was manufactured, sampled, tested, and inspected according to the reference specification and has been found to meet the requirements.

Each certificate of compliance shall include the following information typed on company letterhead:

a) Manufacturer's name or trademark.

b) General description of the component.

c) Reference specification for material (e.g., CGSB 138.1, Fence Fabric for Chain-Link Fence).

d) Signed and dated by the manufacturer's authorized representative.

All certificates of compliance shall be assembled and submitted to the Contract Administrator prior to completion of the Work.

771.08.03 Material Sampling

The Contract Administrator may obtain and test samples to ensure compliance with the specifications. Products represented by the test samples that are not in compliance shall be removed from the Work Area and replaced.

771.09 MEASUREMENT FOR PAYMENT

771.09.01 Actual Measurement

771.09.01.01 Highway Fence

Measurement of highway fence shall be by length in metres along the contour of the ground for the actual length of highway fence installed and shall include gate openings and brace panels.

771.09.01.02 Brace Panels

For measurement purposes, a count shall be made of the number of brace panels installed, regardless of material type.

771.09.01.03 Gates

For measurement purposes, a count shall be made of the gates installed, regardless of the size and type. Double gates shall be counted as one gate.

771.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

771.10 BASIS OF PAYMENT

771.10.01 Highway Fence - Item
Brace Panels - Item
Gates - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Appendix 771-A, April 2022
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Highway fence locations. (771.07.03.01)

- Brace panel locations. (771.07.03.03) Brace panels are computed in accordance with the following requirements:

  a) At cross fences (separating property owners) - 3 panels required; one forming part of the cross fence, and two installed as part of the highway fence.

  b) At cross fences (not separating property owners) - 1 panel is required to be installed on the cross fence at the straining post.

  c) At all horizontal angles exceeding 22 degrees - 2 panels.

  d) On all curves of radius 900 m or less - 2 panels at each end of curve and plus 2 panels at midpoint.

  e) Gate locations and openings - 2 panels at each site in fence.

  f) At all vertical angles exceeding 22 degrees - 2 panels.

  g) At crossings of watercourses (maximum span: 6 m) - 2 panels.

  h) Terminals - 1 panel per terminal.

  i) Existing fence (adjacent to a removed section) - 1 panel per terminal.

  j) New fence - on clear fence runs with none of the above cases - 2 panels at approximately 200 m intervals, with a maximum interval of 230 m.

- Gate locations, types, and sizes. (771.07.05)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 971.101	Fence, Highway, In Earth, Shale, Loose Rock, or Friable Rock, Installation
OPSD 971.102	Fence, Highway, In Solid Rock, Installation
OPSD 971.103	Fence, Highway, Installation Details

CONSTRUCTION SPECIFICATION FOR CHAIN-LINK FENCE

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772-A **Commentary**

772.01 SCOPE

This specification covers the requirements for the installation of chain-link fence.

772.01.01 Specification Significance and Use

This specification has been developed for use in municipal-oriented Contracts. The administration, testing, and payment policies, procedures, and practices reflected in this specification correspond to those used by many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

772.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

772.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 904 Concrete Structures

Ontario Provincial Standard Specifications, Material

OPSS 1541 Chain-Link Fence Components

CSA Standards

W59-13 Welded Steel Construction (Metal Arc Welding)

ASTM International

A 123/A 123M-17	Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
A 780/A 780M-09 (2015)	Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
B 209-14	Aluminum and Aluminum-Alloy Sheet and Plate

772.03 DEFINITIONS

For the purpose of this specification, the following definitions shall apply:

Barbed Wire means the twisted longitudinal wires, termed line wires, to which the barbs are attached.

Barbed Wire Arm means the metal arm to support the barbed wire.

Bottom Wire means the wire installed at the bottom of fence and fastened to the bottom of the fence fabric and extending throughout each section of fence between terminal posts.

Brace Band means a symmetrically formed strip of metal shaped to fit around a post and used with a carriage bolt and nut to attach the rail end or brace rail end to the post. Also, used for attaching barbed wire, tension wire, and other items to a terminal post.

Brace Rail means a tubular or fabricated steel section used for bracing terminal posts.

Corner Post means a terminal post when the direction of the line of fence changes in two or more directions.

Diagonal Brace Wire means the wire used for bracing terminal posts.

End Post means the fence post positioned at the ends of a section of fence.

Fence Post means an upright tubular or fabricated steel member for supporting fencing material.

Fitting means the mechanical connection of various designs, shapes, and metals to join fence components into an integral structure.

Gatepost means a terminal post on each side of a gate forming a gateway.

Hog Ring means a preformed open wire clip designed to close up into a ring to secure chain-link fabric to horizontal top and bottom wires.

Knuckled means the type of selvage obtained by interlocking adjacent wire ends in pairs and then bending the wire ends back into a closed loop.

Line Post means the fence post spaced at regular intervals between terminal posts throughout each section of fence.

Line Post Cap means a cap or top with a loop or hole used to position the top rail or top wire on top of the line posts. It also prevents water from entering the tubular post.

Marcelled Tension Wire means a type of wire manufactured with either a uniform helix or a series of waves put into the wire to facilitate tensioning the wire when installed to support the top or bottom of the chain-link fence fabric.

Post Sleeve means a specified length of tube or pipe set into a concrete retaining wall into which fence posts are placed.

Rail End means a cup-shaped fitting used with a brace band to connect the top rail or brace to a post.

Selvage means the edge finish on woven chain-link fabric joining pairs of pickets. The selvage may be knuckled or twisted.

Straining Post (or Pull Post) means a terminal post in a line of fence to brace a long stretch or to effect a change in elevation along a fence line.

Tension Band means an offset strip of metal shaped to fit around the terminal post and used with a carriage bolt and nut to attach the tension bar to the post.

Tension Bar means the bar used with tension bands to secure the fence fabric to a terminal post.

Terminal Post means end, gate, corner, and straining post.

Terminal Post Cap means a cap atop a post (end, gate, corner or straining post) that prevents water from entering the tubular post.

Top Rail means a tubular or fabricated steel section continuously joined by means of sleeves or couplings throughout all sections of fence extending between terminal posts.

Top Rail Sleeve means a fitting used to join two pieces of top rail when swedged top rail is not used.

Top Wire means the wire installed at the top of fence and extending continuously throughout all sections of fence between terminal posts.

Twisted means the type of selvage obtained by interlocking adjacent wire ends in pairs and then twisting the wire at least two turns with the wire ends above the twist.

Wire Ties means the wire used to tie chain-link fence fabric to line posts, bottom wires, and top rails or top wires.

772.05 MATERIALS

772.05.01 Chain-Link Fence

Chain-link fence components shall be according to OPSS 1541.

772.05.02 Concrete

Concrete shall have a nominal minimum 28-Day compressive strength of 20 MPa.

772.07 CONSTRUCTION

772.07.01 Site Preparation

Prior to the commencement of fencing operations, all debris shall be removed and ground undulations shall be corrected along the fenceline to obtain a smooth and uniform gradient.

All trees, stumps, and brush along the fenceline shall be cut off at ground level and all logs and overhanging branches that interfere with the installation of the fence shall be removed.

772.07.02 Chain-Link Fence

772.07.02.01 General

Chain-link fence shall be installed at locations specified in the Contract Documents.

Survey reference points or permanent property boundary markers shall not be disturbed or moved without the authorization of the Contract Administrator. When it is necessary to set posts adjacent to such points, the posts shall be placed on the roadway side of the property line as close as feasible to the monuments or markers.

772.07.02.02 Post Installation

772.07.02.02.01 General

All posts shall be installed plumb and to the depth specified in the Contract Documents.

Posts shall be cut to the required height above the ground to present a smooth and uniform profile. Line post spacing shall be in equal horizontal distances with a maximum of 3,000 mm between line posts.

All posts shall be fitted with waterproof metal caps designed to fit and fasten securely over the posts. All line post caps shall carry either the top rail or top wire as specified in the Contract Documents.

Corner posts shall be installed at horizontal deflections in the fence line of 10 degrees or more.

Straining posts shall be installed at equal intervals not exceeding 150 m. Additional straining posts shall be installed when changes in vertical alignment of the fence exceed 30 degrees.

772.07.02.02.02 Posts On Concrete Barrier

All posts installed on concrete barrier shall be according to the Contract Documents.

Each post shall be fabricated with a welded steel base plate grade 300W, hot dip galvanized according to ASTM A 123, and according to the Contract Documents. All welds shall be to a low hydrogen classification according to CSA W59. Manual electrodes shall be E7015, E7016, or E7018. All welds shall be continuous.

772.07.02.02.03 Footings

All posts shall be installed according to the Contract Documents.

Concrete placing, curing, and protection from the elements shall be according to OPSS 904.

772.07.02.03 Bracing

A brace rail or brace wire shall be placed diagonally across the panel at all ends and gateposts. Corner and straining posts shall be supported with diagonal braces placed on both sides of the post. The higher end of the diagonal brace shall be connected at the terminal post.

End fittings shall be secured by a 6 mm bolt placed through the fitting and braced at both ends of the brace.

772.07.02.04 Top Rails, Top Wires, and Bottom Wires

Top rails or top wires shall be installed as specified in the Contract Documents.

Top rails or top wires shall be fastened securely to line post tops using waterproof caps.

In sag locations, the post and cap shall be drilled and fastened with a self-tapping screw to ensure a secure fit.

Top rails shall be fastened to terminal posts with centre bands.

Top and bottom wires shall be stretched tight and securely fastened to terminal posts with turnbuckles and centre bands.

One turnbuckle shall be used between terminal posts.

772.07.02.05 Fence Fabric

Fence fabric shall not be installed until the concrete footings have cured for a minimum of 5 Days.

The fabric shall be stretched tight and securely fastened to terminal posts with steel tension bars and steel or aluminum tension bands. The longitudinal axis of the diamond pattern shall be perpendicular to the slope of the top rail or top wire.

The fabric shall be placed on the side of the post nearest the roadway with the barbed edge at the top, except on curves of 50 m or smaller radius, the fabric shall be placed on the side of the post away from the centre of the curve.

The fabric shall be securely fastened to the line posts, bottom wire, and top rail or top wire with wire ties. The fabric shall not be fastened to any diagonal braces.

Manually fastened round wire ties shall engage one strand of the chain-link fence fabric with one end of the tie by wrapping it with two 360 degree turns and then wrapping the body of the tie around the post or top rail a minimum of 180 degrees. The remaining end of the tie shall be secured to the second strand of the chain-link fence fabric by wrapping it with two 360 degree turns. The fabric and the main body of the tie shall be drawn tightly to the rail or post.

Power fastened wire ties shall engage two strands of the chain-link fence fabric at a diamond joint closest to the post or top rail. The manufacturer's installation instructions shall be followed to complete the operation. The ends shall be twisted three full twists or one and one half machine turns. The end of the tie shall be positioned on the post or rail so that it is parallel to the chain-link fence fabric.

The ends of wire ties shall not protrude beyond the vertical plane on either side of the chain-link fence fabric. Protruding ends of wire ties shall be removed.

The hog rings on top and bottom wires shall be installed according to the Contract Documents.

772.07.02.06 Barbed Wire

Barbed wire shall be installed when specified in the Contract Documents. The barbed wire shall be pulled taut to remove all slack and shall be firmly installed in the slots of the barbed wire arms. The ends of the barbed wire shall be securely connected at the terminal posts with brace bands. Barbed wire arms shall be installed with the arm pointing away from the roadway.

772.07.03 Gates

Gates shall be installed at locations and of the type and size as specified in the Contract Documents.

772.07.03.01 Gate Installation

Gates shall be constructed with the fabric on the side furthest from the roadway with the barbed edge at the top.

All gates shall have a chain hook to hold gates open and double gates shall have a steel gate centre rest with a drop bolt for the closed position.

The surface grade within the required gate sweep area shall be low enough to permit free movement of the gate.

772.07.04 Marking

Identification plates, provided by the material supplier, shall be securely attached to the completed fence installation at the following intervals:

a) At the start and end of each fence installation.

b) At a maximum interval of 300 m.

The fence identification plate shall be located within 300 mm of a terminal post with the top of the plate located approximately 300 mm from the top of the fence fabric. The maximum dimensions of the plate shall be 200 by 200 mm. The plate shall be made from 0.81 mm thick anodized aluminum sheet according to ASTM B 209 series 1100 or 5005-H34.

Each fence identification plate shall be engraved with the following information:

a) Contract number.

b) Name or trademark of fence Subcontractor.

c) Name or trademark of fence supplier (i.e., supplier(s) of fence fabric and posts)

d) Date of completed installation (i.e., yyyy-mm).

The height of the letters and numerals shall be within the range of 6 to 32 mm.

772.07.05 Zinc Coating Repairs

Cut ends, field drilled holes, and damaged areas of hot dip galvanized coatings on galvanized components shall be repaired according to ASTM A 780.

772.07.06 Site Restoration

After fence installation, the site shall be cleaned and trimmed and the ground restored to a neat and original condition existent prior to the fencing operations.

772.07.07 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

772.08 QUALITY ASSURANCE

772.08.01 Construction

The Contract Administrator may perform a spot visual inspection to determine conformance with the workmanship, design, and dimensional requirements of this specification.

Failure to conform to the specification may result in a partial or complete inspection of the installation and removal and replacement of all defective workmanship or materials.

772.08.02 Material Certification

Certificates of compliance for each fence component used in the installation shall be provided to the Contract Administrator. The certificate of compliance shall indicate that the material was manufactured, sampled, tested, and inspected in accordance with the reference specification and has been found to meet the requirements.

Each certificate of compliance shall include the following information typed on company letterhead:

a) Manufacturer's name or trademark.

b) General description of the component.

c) Reference specification for material (e.g., CGSB 138.1 Fence Fabric for Chain-Link Fence).

d) Signed and dated by the manufacturer's authorized representative.

All certificates of compliance shall be assembled and submitted to the Contract Administrator prior to completion of the Work.

772.08.03 Material Sampling

The Contract Administrator may obtain and test samples to ensure compliance with the specifications. Products represented by the test samples that are not in compliance shall be removed from the Work Area and replaced.

772.09 MEASUREMENT FOR PAYMENT

772.09.01 Actual Measurement

772.09.01.01 Chain-Link Fence

Measurement of chain-link fence shall be by length in metres along the contour of the ground for the actual length of fence installed and shall include gate openings.

772.09.01.02 Gates

For measurement purposes, a count shall be made of the number of gates installed, regardless of the size and type. Double gates shall be counted as one gate.

772.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

772.10 BASIS OF PAYMENT

772.10.01 Chain-Link Fence - Item
Gates - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

772.10.02 Removals and Replacements

Costs associated with any required removals and replacements of defective workmanship or materials shall be the Contractor's responsibility at no cost to the Owner.

Appendix 772-A, April 2019
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Chain-link fence locations. (772.07.02.01)

- Locations of top rail or top wire to be used. (772.07.02.02.01)

- Barbed wire locations. (772.07.02.06)

- Gate locations, type, and size. (772.07.03)

The designer should consider the placement of the fence fabric in relation to the post when the fence is located between two roadways and when snow loading from ploughing operations could separate the fence fabric from the post, (e.g., freeway and service road).

When chain-link fence is located adjacent to a highway, a top rail represents a potential spearing hazard. The default installation method will be to install chain-link fence with top wire. For those installations where the chain-link fence will be installed in a non-roadside installation (e.g., park, recreation facility, storm water management facility, etc.), when, as a minimum, the chain-link fence is located beyond the clear zone, the designer may specify a top rail when desired. (772.07.02.02.01 and 772.07.02.04)

See MTO Roadside Design Manual for additional information.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 972.101	Fence, Chain-Link, Component - Barbed Wire
OPSD 972.102	Fence, Chain-Link, Component - Gate
OPSD 972.130	Fence, Chain-Link, Installation - Roadway
OPSD 972.131	Fence, Chain-Link, Installation - Concrete Barrier
OPSD 972.132	Fence, Chain-Link, Details and Table

CONSTRUCTION SPECIFICATION FOR WILDLIFE FENCE

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773.10 **BASIS OF PAYMENT**

APPENDICES

773-A **Commentary**

773.01 SCOPE

This specification covers the requirements for the installation of wildlife fence.

773.01.01 Specification Significance and Use

This specification has been developed for use in municipal-oriented Contracts. The administration, testing, and payment policies, procedures, and practices reflected in this specification correspond to those used by many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

773.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

773.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 201	Clearing, Close Cut Clearing, Grubbing, and Removal of Surface and Piled Boulders
OPSS 206	Grading
OPSS 802	Topsoil
OPSS 804	Seed and Cover
OPSS 904	Concrete Structures

Ontario Provincial Standard Specifications, Material

OPSS 1540	Standard Highway Fence Components
OPSS 1541	Chain-Link Fence Components
OPSS 1601	Wood, Preservative Treatment, and Shop Fabrication

Canadian General Standards Board (CGSB)

138.1-2019	Fabric for Chain Link Fence
138.2-2019	Steel Framework for Chain Link Fence

ASTM International

A27/A27M-20	Steel Castings, Carbon, for General Application
A116-11(2016)	Metallic-Coated, Steel-Woven Wire Fence Fabric
A153/A153M-16a	Zinc Coating (Hot-Dip) on Iron and Steel Hardware

A240/A240M-20a	Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
A491-11(2017)	Aluminum-Coated Steel Chain-Link Fence Fabric
A780/A780M-20a	Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
A824-01(2017)	Metallic-Coated Steel Marcelled Tension Wire for Use with Chain Link Fence
B209**-**B209M-21a	Aluminum and Aluminum-Alloy Sheet and Plate
F626-14(2019)	Fence Fittings
F668-17	Polyvinyl Chloride (PVC), Polyolefin and Other Polymer-Coated Steel Chain Link Fence Fabric

773.03 DEFINITIONS

For the purpose of this specification, the following definitions shall apply:

Apron means a dense fence fabric attached to the bottom potion of a wire fence fabric designed to exclude wildlife that would otherwise be able to traverse through.

Barbed Wire Arm means the metal arm to support line wire or fence fabric.

Bottom Wire means the wire installed at the bottom of fence and fastened to the bottom of the fence fabric and extending throughout each section of fence between terminal posts.

Brace Band means a symmetrically formed strip of metal shaped to fit around a post and used with a carriage bolt and nut to attach the rail end or brace rail end to the post. Also, used for attaching barbed wire, tension wire, and other items to a terminal post.

Brace Rail means a tubular or fabricated steel section, or rectangular wood section used for bracing terminal posts.

Corner Post means a terminal post when the direction of the line of fence changes in two or more directions.

Diagonal Brace Wire means the wire used for bracing terminal posts.

End Post means the fence post positioned at the ends of a section of fence.

Fence Post means an upright tubular or fabricated steel, or rectangular wooden member for supporting fencing material.

Fitting means the mechanical connection of various designs, shapes, and metals to join fence components into an integral structure.

Hog Ring means a preformed open wire clip designed to close up into a ring to secure chain-link fabric to horizontal top and bottom wires.

Knuckled means the type of selvage obtained by interlocking adjacent wire ends in pairs and then bending the wire ends back into a closed loop.

Line Post means the fence post spaced at regular intervals between terminal posts throughout each section of fence.

Line Wire means the horizontal wire of the fence fabric.

Marcelled Tension Wire means a type of wire manufactured with either a uniform helix or a series of waves put into the wire to facilitate tensioning the wire when installed to support the top or bottom of the fence fabric.

Muffler Clamp means a round or U-shaped fitting used to connect horizontal fence fabric wires to the line post.

Post Cap means a cap atop a post that prevents water from entering the tubular post.

Rail End means a cup-shaped fitting used with a brace band to connect the top rail or brace to a post.

Selvage means the edge finish on woven chain-link fabric joining pairs of pickets. The selvage may be knuckled or twisted.

Stay Wire means the vertical wire that is woven or wrapped around the line wire to form the rectangular opening of the fence fabric.

Straining Post (or Pull Post) means a terminal post in a line of fence to brace a long stretch or to effect a change in elevation along a fence line.

Tension Band means an offset strip of metal shaped to fit around the terminal post and used with a carriage bolt and nut to attach the tension bar to the post.

Tension Bar means the bar used with tension bands to secure the fence fabric to a terminal post.

Terminal Post means end, gate, corner, and straining post.

Top Wire means the wire installed at the top of fence and extending continuously throughout all sections of fence between terminal posts.

Twisted means the type of selvage obtained by interlocking adjacent wire ends in pairs and then twisting the wire at least two turns with the wire ends above the twist.

Wildlife Escape means an earth structure constructed to provide egress for wildlife from the highway right of way.

Wire Ties means the wire used to tie chain-link fence fabric to line posts, bottom wires, and top rails or top wires.

773.04 DESIGN AND SUBMISSION REQUIREMENTS

773.04.01 Submission Requirements

Three sets of Working Drawings shall be submitted to the Contract Administrator at least 7 Days prior to commencement of the construction of retained soil systems for wildlife escapes, for information purposes only. Prior to making a submission, the seals and signatures of a design Engineer and a design-checking Engineer shall be affixed on the Working Drawings verifying that the drawings are consistent with the Contract Documents.

773.05 MATERIALS

773.05.01 Type A Fence Fabric

The fence fabric shall be according to Table 1.

Locks or fastening at the intersections of the line and stay wires of the woven fence fabric shall prevent longitudinal and vertical slipping.

Fence fabric shall be galvanized prior to fabrication to provide a minimum weight of metallic coating according to ASTM A116, Class 3.

773.05.01.01 Mechanical Splicing Units and Crimp Sleeves

Mechanical splice units or crimp sleeves shall provide a maximum load carrying capacity that meets or exceeds the minimum breaking strength of the fence fabric line wires. For 2.51 mm diameter line wire, the minimum breaking strength of the splice shall be 5,990 N.

773.05.02 Type B Fence Fabric

The fence fabric shall be 1200 mm wide as specified in the Contract Documents with a uniform 9.53 mm or 6.35 mm diamond pattern. The fence fabric shall be knuckled at both selvages.

The steel wire shall be according to CAN/CGSB 138.1. Aluminum coating shall be according to ASTM A491. Polyvinyl chloride (PVC) coating shall be according to ASTM F668. The fence fabric shall be according to Table 2.

773.05.03 Posts and Brace Rails

Steel tubular posts and brace rails shall be according to OPSS 1541.

Steel T-rail posts shall be according to OPSS 1540, fabricated to a length that allows for the fence to be constructed to the required height above ground.

Wooden posts and brace rails shall be according to OPSS 1601. Wooden posts and brace rails shall be S-P-F species No. 1 or No. 2 grade. Wooden posts shall be stamped for grade, species, and treatment.

773.05.04 Wire

Top wire, bottom wire, and brace wire shall be 4.50 mm diameter marcelled tension wire Type II according to ASTM A824 with a minimum Class 5 galvanized coating.

773.05.05 Fittings

Tension bars, tension bands, brace bands, top rail sleeves, and rail ends shall be according to ASTM F626.

Diagonal wooden braces and diagonal brace wire shall be according to OPSS 1540.

Barbed wire arms shall be fabricated from galvanized pressed steel or cast iron according to CAN/CGSB 138.2 or ASTM F626. Barbed wire arms shall be single slanted arm type with slots to accept three strands of wire. The installed position of the barbed wire arm shall project at an angle of 45 degrees ± 5 degrees from the vertical plane of the fence line. Barbed wire arms shall be equipped with a screw down fitting. Barbed wire arms used for Type B fence shall carry the top wire as specified in the Contract Documents.

Post caps shall be according to ASTM F626.

773.05.06 Hardware

All required hardware including, but not limited to carriage bolts and nuts, shall be hot dip galvanized according to ASTM A153M.

773.05.07 Fasteners

Wire ties for attaching the fence fabric to line posts, bottom wires, and top wires shall be according to ASTM F626.

Wire ties for attaching the fence fabric to line posts shall be manually fastened round wire ties, 3.76 mm diameter steel wire, with a minimum 488 g/m² galvanized coating.

Wire ties for attaching the fence fabric to bottom or top wires shall be round wire hog rings, 2.69 mm diameter steel wire, with a minimum 488 g/m² galvanized coating.

Staples shall be according to OPSS 1540.

Muffler clamps shall be Type 304 or approved equivalent stainless steel according to ASTM A240M.

773.05.08 Turnbuckles

Turnbuckles shall be drop forged steel according to ASTM A27M and shall be galvanized according to ASTM A153M.

773.05.09 Concrete

Concrete shall have a nominal minimum 28-Day compressive strength of 20 MPa.

773.07 CONSTRUCTION

773.07.01 Site Preparation

Prior to the commencement of fencing operations, all debris shall be removed and ground undulations shall be graded along the fence line to obtain a smooth and uniform gradient. Where undulating bedrock is present, the ground shall be prepared such that earth can be added to embed the bottom 200 mm of the fence fabric. Grading shall be according to OPSS 206.

All trees, stumps, and brush along the fence line shall be cut off at ground level and all logs and overhanging branches that interfere with the installation of the fence shall be removed. All selective clearing and fence installation shall be a minimum of 5 metres from the limit of the right-of-way.

773.07.02 Selective Clearing

When fencing is required through wooded areas that are not designated for clearing and grubbing, only selective clearing shall be permitted in order to gain access to the fence line and to permit fence installation with lightweight equipment. Clearing shall be kept to a minimum and shall be subject to the approval of the Contract Administrator prior to the commencement of any clearing operation. Travel around obstructions may be required.

The location of access points shall be based on the least amount of clearing required and the frequency of access points shall be subject to reasonable material delivery requirements. The access points shall be approved by the Contract Administrator.

773.07.03 Wildlife Fence

773.07.03.01 General

Wildlife fence shall be installed at locations as specified in the Contract Documents. Fence locations shall be staked on-site and approved by the Contract Administrator prior to installation.

Control monument or property monument shall not be disturbed or moved without the authorization of the Contract Administrator. When it is necessary to set posts adjacent to those control or property monuments, posts shall be placed on the roadway side of the property line as close as feasible to the control or property monuments.

773.07.03.02 Post Installation

773.07.03.02.01 General

All posts shall be installed plumb and to the alignment as specified in the Contract Documents, regardless of the substrate material encountered.

Posts shall be cut to the required height above the ground to present a smooth and uniform profile.

All steel tubular posts not fitted with barbed wire arms shall be fitted with waterproof metal post caps designed to fit and fasten securely over the posts.

773.07.03.02.02 Terminal Posts

Corner posts shall be installed at horizontal deflections in the fence line of 10 degrees or more.

Straining posts shall be installed at equal intervals not exceeding 150 m. Additional straining posts shall be installed when changes in vertical alignment of the fence exceed 30 degrees.

Terminal posts shall be installed at all fence ends and both sides of all openings and gates. Terminal posts shall be installed on each side of watercourse crossings.

Terminal posts shall be installed such that gaps at escape ramps and wildlife crossing structures are minimized.

773.07.03.02.03 Footings

Concrete placement, curing, and protection from the elements shall be according to OPSS 904.

773.07.03.02.04 Post Installation in Rock

When rock is encountered, posts shall be installed as specified in the Contract Documents.

773.07.03.02.05 Post Installation in High Water Areas

In areas with high, stagnant water such as swamps, tubular steel posts may be substituted with T-rail posts. T-rail posts shall be driven to competent ground in a manner such that they are not bent or burred.

773.07.03.02.06 Cutting Wooden Posts

When a wooden post top is cut, it shall be beveled at a 15 to 30° angle, sloping towards the roadway. Cut ends shall receive two applications of 2% copper naphthenate wood preservative. Field applied wood preservative that comes in contact with any metal components shall be removed immediately.

773.07.03.03 Bracing

Bracing shall be installed at all terminal posts. Corner and straining posts shall be supported with bracing placed on both sides of the post.

Bracing shall include the installation of brace rail, diagonal brace wire, hardware, and fasteners as specified in the Contract Documents.

The higher end of the diagonal brace shall be connected at the terminal post. End fittings shall be secured by a 6 mm bolt placed through the fitting and braced at both ends of the brace.

773.07.03.04 Fence Fabric

Fence fabric shall not be installed until the concrete footings have cured for a minimum of 5 Days.

Fence fabric shall be placed on the side of the post opposite the roadway.

773.07.03.04.01 Type A

Type A fence fabric shall be uniformly tensioned so that its line wires are tight and parallel and the stay wires are straight, uniformly spaced, and at right angles to the line wires.

Fence fabric shall be fastened to the steel post as specified in the Contract Documents using wire ties or muffler clamps.

An apron made of Type B fence fabric shall be installed along the bottom of the fence when specified in the Contract Documents.

Fence fabric shall be tensioned and terminated to ensure that the full strength of the fence fabric is maintained. Line wire termination shall be completed at the terminal posts by:

a) Wrapping each line wire around the terminal post at least once and around itself at least four complete turns; or

b) Wrapping each line wire around the terminal post at least once and terminating the line wire with a mechanical splicing unit or crimp sleeves according to the manufacturer’s instructions.

Rolls shall be spliced together, such that each adjoining pair of the 20 line wires is soundly connected using mechanical splicing units or crimp sleeves according to the manufacturer's instructions.

After splicing, all projecting ends of the line wires shall be removed. Terminal posts shall not be installed for splice purposes only.

773.07.03.04.02 Type B

Fence fabric shall be stretched tight and securely fastened to terminal posts with steel tension bars and steel tension bands. The longitudinal axis of the diamond pattern shall be perpendicular to the slope of the top wire.

Fence fabric shall be securely fastened to the line posts, bottom wire, and top wire with wire ties or staples as specified in the Contract Documents. The bottom 200 mm of Type B fence fabric shall be embedded in earth as specified in the Contract Documents.

Power fastened wire ties shall engage two strands of the chain-link fence fabric at a diamond joint closest to the post. The manufacturer's installation instructions shall be followed to complete the operation. Ends shall be twisted three full twists or one and one half machine turns. The end of the tie shall be positioned on the post or rail so that it is parallel to the fence fabric.

Ends of wire ties shall not protrude beyond the vertical plane on either side of the fence fabric. Protruding ends of wire ties shall be removed.

Hog rings on top and bottom wires shall be installed as specified in the Contract Documents.

773.07.03.05 Barbed Wire Arms

Barbed wire arms shall be secured to the post using screw down fittings.

773.07.03.06 Gates

Gates shall be installed at locations and of the type and size as specified in the Contract Documents.

Gates shall be constructed with the fabric on the side furthest from the roadway.

All gates shall have a chain hook to allow gates to be held open.

The surface grade within the required gate sweep area shall be low enough to permit free movement of the gate.

773.07.03.07 Marking

Identification plates provided by the material supplier shall be securely attached to the completed fence installation at the following intervals:

a) At the start and end of each fence installation.

b) At a maximum interval of 300 m.

The fence identification plate shall be located within 300 mm of a terminal post with the bottom of the plate located approximately 1300 mm from the ground for Type A fence and 575 mm from the ground for Type B fence. The maximum dimensions of the plate shall be 200 by 200 mm. The plate shall be made from 0.81 mm thick anodized aluminum sheet according to ASTM B209, series 1100 or 5005-H34.

Each fence identification plate shall be engraved with the following information:

a) Contract number.

b) Name or trademark of fence Subcontractor.

c) Name or trademark of fence supplier (i.e., supplier of fence fabric and posts).

d) Date of completed installation (i.e., yyyy-mm).

The height of the letters and numerals shall be within the range of 6 to 32 mm.

773.07.03.08 Zinc Coating Repairs

Cut ends, field drilled holes, and damaged areas of hot dip galvanized coatings on galvanized components, except fence fabric, shall be repaired according to ASTM A780M.

773.07.03.09 Site Restoration

After the fence installation, the site shall be cleaned and trimmed, and the ground restored to a neat condition.

773.07.03.10 Tolerances

As-constructed post spacing shall be within ± 300 mm of the dimensions as specified in the Contract Documents.

As-constructed vertical dimensions shall be within ± 50 mm of those as specified in the Contract Documents.

773.07.04 Wildlife Escapes

773.07.04.01 Site Preparation

All trees, stumps, and brush within the footprint of the wildlife escape and landing area shall be cut off at ground level and all logs and overhanging branches that interfere with the construction of the wildlife escape shall be removed.

Excavation required to achieve the required cross section of the landing area shall be according to OPSS 206.

773.07.04.02 Placement of Fill

Placement of earth for wildlife escapes shall be according to OPSS 206.

773.07.04.03 Retained Soil Systems

Retained soil systems for wildlife escapes shall be constructed according to the Working Drawings.

773.07.04.04 Landing Area

The landing area shall be cleared and grubbed according to OPSS 201.

Topsoil shall be according to OPSS 802.

Seed and cover shall be according to OPSS 804.

773.07.04.05 Tolerances

As-constructed wildlife escapes shall be within +/- 100 mm of the dimensions as specified in the Contract Documents.

773.07.05 Management of Excess Material

Management of excess material shall be as specified in the Contract Documents.

773.08 QUALITY ASSURANCE

773.08.01 Construction

The Contract Administrator may perform a spot visual inspection to determine conformance with the workmanship, design, and dimensional requirements of this specification.

Failure to conform to the specification may result in a partial or complete inspection of the installation by the Contract Administrator and removal and replacement of all defective workmanship or materials by the Contractor.

773.08.02 Material Certification

Certificates of compliance for each fence component used in the installation shall be provided to the Contract Administrator. The certificate of compliance shall indicate that the material was manufactured, sampled, tested, and inspected in accordance with the reference specification and has been found to meet the requirements.

Each certificate of compliance shall include the following information typed on company letterhead:

a) Manufacturer's name or trademark.

b) General description of the component.

c) Reference specification for material (e.g., CGSB 138.1 Fence Fabric for Chain Link Fence).

d) Signed and dated by the manufacturer's authorized representative.

All certificates of compliance shall be assembled and submitted to the Contract Administrator prior to completion of the Work.

773.08.03 Material Sampling

The Contract Administrator may obtain and test samples to ensure compliance with the specifications. Products represented by the test samples that are not in compliance shall be removed from the Work Area and replaced.

773.09 MEASUREMENT FOR PAYMENT

773.09.01 Actual Measurement

773.09.01.01 Wildlife Fence, Type A
Wildlife Fence, Type A, with Apron, Type B, 6.35 mm Fabric Opening
Wildlife Fence, Type A, with Apron, Type B, 9.53 mm Fabric Opening
Wildlife Fence, Type B, 6.35 mm Fabric Opening, Steel Posts
Wildlife Fence, Type B, 9.53 mm Fabric Opening, Steel Posts
Wildlife Fence, Type B, 6.35 mm Fabric Opening, Wooden Posts
Wildlife Fence, Type B, 9.53 mm Fabric Opening, Wooden Posts

Measurement of wildlife fence shall be by length in metres along the contour of the ground for the actual length of wildlife fence installed with no deduction made for wildlife escapes.

773.09.01.02 Wildlife Fence, Type A, Access Gate
Wildlife Fence, Type A, Brace Panel
Wildlife Fence, Type B, Brace Panel, Wooden
Wildlife Fence, Type B, Brace Panel, Steel
Wildlife Escape

For measurement purposes, a count shall be made of the number of access gates, brace panels and wildlife escapes installed, regardless of material type.

773.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

773.10 BASIS OF PAYMENT

773.10.01

Wildlife Fence, Type A - Item
Wildlife Fence, Type A, with Apron, Type B, 6.35 mm Fabric Opening - Item
Wildlife Fence, Type A, with Apron, Type B, 9.53 mm Fabric Opening - Item
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Wildlife Fence, Type A, Access Gate - Item
Wildlife Fence, Type A, Brace Panel - Item
Wildlife Fence, Type B, Brace Panel, Wooden - Item
Wildlife Fence, Type B, Brace Panel, Steel - Item
Wildlife Escape - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Grading up to 300 mm shall be included as part of all wildlife fencing installation. For earth grading requirements greater than 300 mm, the full grading is provided under the earth excavation item or earth borrow item as appropriate.

Table 1
Type A Fence Fabric

Fence Fabric Design Number	Number of Horizontal Wires	Height (mm)	Wire Diameter (mm)	Stay Wire Spacing (mm)
2096-6-12.5 (ASTM A116)	20	2440	2.51	150

Table 2
Type B Fence Fabric

Type	Size (mm)	Nominal Diameter of Coated Wire (mm)	Minimum Weight of Coating (g/m^2)	Minimum Wire Breaking Strength (N)
Class B - Zinc-Coated Galvanized Non-Woven Steel Fabric	6.35	1.19	150	539
Class B - Zinc-Coated Galvanized Before Weaving (WGW) Steel Fabric	9.53	2.03	488	1690
Class B - Aluminum Coated Before Weaving Steel Fabric	9.53	3.05	105	3600
Class B - PVC Coated Before Weaving Steel Fabric	9.53	2.31	0.38 (Note 1)	2700
Note 1: This value is the minimum thickness of vinyl coating measured in mm.				

Appendix 773-A, November 2022
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Wildlife fence locations. (773.07.03.01)

- Apron locations. (773.07.03.04.01)

- Gate locations, type, and size. (773.07.03.06)

The MTO Environmental Guide for Mitigating Road Impacts to Wildlife and the Ministry of Natural Resources and Forestry (MNRF) Best Management Practices for Mitigating the Effects of Roads on Amphibian and Reptile Species at Risk in Ontario may be referenced for guidance.

The designer shall consult with the environmental authority in determining the location and type of fence required, including any wildlife escapes and crossing structures.

MNRF staff with qualifications and species-specific expertise related to large mammals, reptiles including turtles and snakes, amphibians; and as applicable, species at risk; should be consulted during the design of wildlife fence, wildlife escapes, and crossing structures.

Fence Fabric

Wildlife Fence - Type A shall be specified when wildlife fence is required for large mammals.

Wildlife Fence - Type A with an apron made of Type B fence fabric attached at the bottom shall be used when wildlife fence is required for both large mammals and reptiles and/or amphibians.

Wildlife Fence - Type B shall be specified when wildlife fence is required for reptiles and/or amphibians.

Although the target species and the cost are important considerations in the selection of fence fabric, durability and fence maintenance requirements must also be carefully considered when selecting an appropriate material.

Wildlife Fence - Type B shall be designed in consideration of the location and the species that the fence is being implemented to protect from road mortality and/or to funnel to an associated wildlife escape or crossing structure. For example, some reptiles and amphibians may become entrapped in the larger Type B fence fabric opening (9.53 mm) and some snakes may be able to climb up to a metre. In some cases, the smaller Type B fence fabric opening (6.35 mm) may be more suitable or a solid plastic fence type may be considered on a non-standard basis. However, where a fence will be situated closer to the roadway such that it may be impacted by snow load from ploughing during winter maintenance, the 9.53 mm opening should be considered.

Where Type B fence is installed in earth sections the buried portion of the fence fabric shall be covered with material excavated during installation.

Where Type B fence fabric is required to be buried under earth above grade in a rock installation, it shall be included in the item for earth depths up to 300 mm. Where required earth depth exceeds 300 mm, the earth shall be included in the earth borrow item.

Posts

Wildlife Fence - Type A shall be designed with steel posts when in earth or rock terrain.

Wildlife Fence - Type B may be designed with either steel posts or wooden posts. The designer shall specify wooden posts on sections of Type B fence located within the clear zone described in Chapter 2 of the Roadside Design Manual.

Where Wildlife Fence - Type A or Type B must be installed in locations inundated with water such as wetlands or surface water bodies, these locations shall be clearly shown on the Contract Drawings. Timing windows for in-water work shall be obtained from MNRF and provided in the Contract Documents along with methods and constraints for backfilling steel T-rail or tubular posts in-water. In addition, additional fence height may need to be specified for Type B reptile fence depending on the depth of water.

Fence Ends

Installing a wildlife fence without providing a crossing opportunity limits reduction in road mortality and increases fence-end/gap effects. Ensuring that the fence spans the entire identified habitat area along the right-of-way to the greatest extent possible will help reduce the fence-end/gap effect. The fence-end/gap effect can also be significantly mitigated by ensuring that the design provides for terminal posts being tied in or installed as close to each wildlife escape and crossing structure (culvert) as possible without compromising the integrity of the escape or structure so that animals cannot squeeze through between them and the fence-end.

Where a fence ends at an interchange ramp, measures to deter wildlife from entering the highway where the fence ends at both sides of the interchange shall be considered such as rip-rap or cattle guards/Texas gates, unless the fence can be tied into a natural or engineered barrier such as a vertical rock face or a retained soil system that wildlife would not be able to traverse.

Where a fence ties into adjacent wildlife underpasses on a divided highway, lengths of wildlife fence shall be included between the underpasses such that wildlife access to the median is eliminated.

Where a Type B fence does not terminate at a natural or engineered barrier, or where the fence is interrupted by entrances such as driveways, the ends of the fence shall be doubled back with a turnaround to redirect wildlife along the length of the fence and away from openings that may provide access to the roadway. The additional length of fence shall be included in the quantity sheets on the same line as the adjacent length of fence. Total length shall be either 6.0 or 9.0 m. The turnaround shall be shown on the Contract Drawings with the appropriate drawing number, and any required modifications to suit field conditions.

Gates

A gate shall be provided where access is required from the highway right-of-way to adjacent property such as utility corridors.

Wildlife Escapes

Where wildlife escapes are used in conjunction with Wildlife Fence - Type A, all clearing, grubbing, excavation, earth and retained soil systems are included in the item. The designer shall include topsoil, and seed and cover under the appropriate tender item. Topsoil under landing areas shall be 300 mm thick.

A Foundation Investigation and Design Report shall be prepared for each retained soil system location and included in the Contract Documents. The design of the wildlife escape, including the retained soil system, shall be the responsibility of the Contractor.

See MTO Roadside Design Manual for additional information.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 973.131	Wildlife Fence, Type A, with Apron of Type B Fence Fabric
OPSD 973.132	Wildlife Fence, Type A, Access Gate
OPSD 973.133	Wildlife Fence, Type B, on Steel Posts, Installation
OPSD 973.134	Wildlife Fence, Type B, on Wooden Posts, Installation
OPSD 973.135	Wildlife Fence, Type A, Installation
OPSD 973.140	Wildlife Fence, Steel Post Footing Details
OPSD 973.141	Wildlife Fence, Wooden Post Installation Details
OPSD 973.142	Wildlife Fence, Miscellaneous Details
OPSD 973.143	Wildlife Fence, Tie-In at Culverts or Wildlife Crossing Structures
OPSD 973.144	Wildlife Escape
OPSD 973.145	Wildlife Fence, Type B, Fence End Turnaround

CONSTRUCTION SPECIFICATION FOR EXPANDED METAL ANTI-GLARE SCREEN

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APPENDICES

791-A **Commentary**

791.01 SCOPE

This specification covers the requirements for the installation of expanded metal anti-glare screens on chain-link fence.

791.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

791.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

791.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

ASTM International

A153/A153M-16a	Zinc Coating (Hot-Dip) on Iron and Steel Hardware
A1011/A1011M-18a	Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
B209-14	Aluminum and Aluminum-Alloy Sheet and Plate
F3125/F3125M-19e2	High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength

791.05 MATERIALS

791.05.01 Mesh

Steel mesh panels shall be fabricated from expanding quality hot rolled sheets according to ASTM A1011M.

Aluminum mesh panels shall be fabricated from expanding utility grade 3003 H14 sheets or 1100 H14 rolls.

Mesh panels shall consist of regular 19 mm diamond shaped patterns formed by expanding 1.6 mm thick panels to provide panels 1,200 mm in width and a minimum of 2,400 mm plus one diamond width in length. The diamonds shall be according to the following:

a) Width of diamond, centre to centre of strand shall be 22 mm.

b) Length of diamond, centre to centre of strand shall be 50 mm.

c) Width of strand shall be 5 mm.

d) Cut-off angle shall be a minimum of 21 degrees.

The size of the finished mesh panels shall not deviate more than 3 mm from the specified width and more than 12 mm from the specified length.

Mesh panels shall be levelled and wire brushed after the expanding operation.

Mesh panels fabricated from steel sheets shall be hot dip galvanized after fabrication to provide a mass of zinc coating not less than 610 g/m^2 of total surface.

791.05.02 Miscellaneous Hardware

Washers, nuts, and bolts shall be according to ASTM F3125. All hardware shall be galvanized according to ASTM A153 and to provide a mass of zinc coating of not less than 305 g/m^2 of total surface.

Metal discs used to fasten mesh panels to the chain-link fence fabric shall be fabricated from 1.6 mm thick steel and hot dip galvanized after fabrication to provide a mass of zinc coating of not less than 610 g/m^2 of the total surface.

791.07 CONSTRUCTION

791.07.01 General

Expanded metal anti-glare screens shall be installed at locations specified in the Contract Documents. Mesh panels shall be oriented as specified in the Contract Documents.

791.07.02 Expanded Metal Anti-Glare Screens on Chain-Link Fence

Mesh panels shall be fastened to the chain-link fence as specified in the Contract Documents.

791.07.03 Marking

Identification plates, provided by the material supplier, shall be securely attached to the completed expanded metal anti-glare screen installation at the following intervals:

a) At the start and end of each expanded metal anti-glare screen installation.

b) At a maximum interval of 300 m.

The expanded metal anti-glare screen identification plate shall be located approximately 300 mm from the top of the expanded metal anti-glare screen to the top of the plate. The maximum dimensions of the plate shall be 200 by 200 mm. The plate shall be made from 0.81 mm thick anodized aluminum sheet according to ASTM B209 series 1100 or 5005-H34.

Each expanded metal anti-glare screen identification plate shall be engraved with the following information:

a) Contract number.

b) Name or trademark of anti-glare screen Subcontractor.

c) Name or trademark of anti-glare screen supplier (i.e., suppliers of expanded metal anti-glare screen and posts).

d) Date of completed installation (i.e., yyyy-mm).

The height of the letters and numerals shall be within the range of 6 to 32 mm.

791.07.04 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

791.08 QUALITY ASSURANCE

791.08.01 Construction

The Contract Administrator may perform a spot visual inspection to determine conformance with the workmanship, design, and dimensional requirements of this specification.

Failure to conform to the specifications may result in a partial or complete inspection of the installation and removal and replacement of all defective workmanship or materials.

791.09 MEASUREMENT FOR PAYMENT

791.09.01 Actual Measurement

791.09.01.01 Expanded Metal Anti-Glare Screen

Measurement of expanded metal anti-glare screen shall be by length in metres along the length of chain-link fence for the actual length of screen installed.

791.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

791.10 BASIS OF PAYMENT

791.10.01 Expanded Metal Anti-Glare Screen - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

Appendix 791-A, April 2021
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Locations of expanded metal anti-glare screens. (791.07.01)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 991.132 Expanded Metal Anti-Glare Screen, Installation - Chain-Link Fence

CONSTRUCTION SPECIFICATION FOR THE PROTECTION OF TREES

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801.10 **BASIS OF PAYMENT**

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801-A **Commentary**

801.01 SCOPE

This specification describes the measures required to protect trees not designated for removal.

801.01.01 Specification Significance and Use

This specification has been developed for use in municipal-oriented Contracts. The administration, testing, and payment policies, procedures, and practices reflected in this specification correspond to those used by many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

801.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

801.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Barrier means a fence placed around a single tree or group of trees to protect them from removal and injury.

Dripline means the location on the ground surface directly beneath the theoretical vertical line from the tips of the outermost branches of the trees.

801.07 CONSTRUCTION

801.07.01 Operational Constraints

Trees not designated for removal shall not be damaged and shall be protected from flooding and sediment deposits from construction operations.

Equipment and vehicles shall not be operated within the dripline of trees not designated for removal unless specified in the Contract Documents. In such cases, operation of equipment shall be kept to the minimum necessary to perform the work required.

Equipment or vehicles shall not be parked, repaired, or fuelled within the dripline of any tree not designated for removal.

Construction materials and earth shall not be stockpiled within the dripline of any tree not designated for removal.

801.07.02 Barrier for Tree Protection

Barriers for tree protection shall be as specified in the Contract Documents. A barrier shall consist of material approved by the Contract Administrator, supported by posts.

The barriers shall be installed within the Working Area, prior to commencement of construction operations at locations specified in the Contract Documents. Where a clearance zone of 1.5 m cannot be established between the barrier at the dripline and the limit of grading, the barrier may be placed within the dripline, subject to the approval of the Contract Administrator.

The barriers shall be maintained vertical and in good repair throughout the duration of construction operations without breaks or unsupported sections and, shall be removed upon completion of the work.

801.07.03 Tree Repair

Trees not designated for removal that are damaged by construction operations shall be repaired as follows, within five Days of the damage:

a) Branches 25 mm or greater in diameter that are broken shall be cut back cleanly on the tree side of the break or to within 10 mm of their base, if a substantial portion of the branch is damaged.

b) Roots 25 mm or larger in diameter that are exposed shall be cut back cleanly to the soil surface.

c) Bark that is damaged shall be neatly trimmed back to uninjured bark without causing further injury to the tree.

801.07.04 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

801.09 MEASUREMENT FOR PAYMENT

801.09.01 Actual Measurement

801.09.01.01 Barrier for Tree Protection

Measurement shall be in linear metres measured along the length of the barrier. Overlaps shall not be measured.

801.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clause under Actual Measurement.

801.10 BASIS FOR PAYMENT

801.10.01 Barrier for Tree Protection - Item

Payment at the Contract price for the above item shall be full compensation for all labour, Equipment, and Material required to do the work.

Progress payments shall be based on the following percentage of the Contract price:

60% for supply and installation
25% for maintenance
15% for removal

When there is not a separate item for Barrier for Tree Protection, payment at the Contract price for the applicable tender items of the Contract that necessitate the placing of barriers for tree protection shall include full compensation for all labour, Equipment, and Material to do the work of protecting and repairing trees not designated for removal.

Appendix 801-A, November 2019
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Locations of barriers for tree protection at trees or woodlot edges. (801.07.02)

- Locations of barriers for tree protection beyond the dripline. (801.07.02)

The designer should determine the following are required and, if so, the requirements should be included in the Contract Documents:

- The need to operate equipment and vehicles within the dripline of trees not designated for removal. (801.07.01)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 220.010 Barrier for Tree Protection

CONSTRUCTION SPECIFICATION FOR TOPSOIL

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802.09 **MEASUREMENT FOR PAYMENT**

802.10 **BASIS OF PAYMENT**

APPENDICES

802-A **Commentary**

802.01 SCOPE

This specification covers the requirements for stockpiling, supplying, and placing topsoil.

802.01.01 Specification Significance and Use

This specification has been developed for use in municipal-oriented Contracts. The administration, testing, and payment policies, procedures, and practices reflected in this specification correspond to those used by many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

802.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

802.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 206 Grading
OPSS 501 Compaction
OPSS 804 Seed and Cover
OPSS 805 Temporary Erosion and Sediment Control Measures

Ontario Provincial Standard Specifications, Materials

OPSS 1860 Geotextiles

Ontario Ministry of Transportation Publications

Laboratory Testing Manual:
LS-706 Moisture - Density Relationship of Soils Using 2.5 kg Rammer and 305 mm Drop

ASTM International

D2974-14 Moisture, Ash, and Organic Matter of Peat and Other Organic Soils
D4972-13 pH of Soils

802.05 MATERIALS

802.05.01 Topsoil

Topsoil shall be a fertile loam material that is free of roots, vegetation, or other debris of a size and quantity that prevents proper placement of the topsoil. The topsoil shall not contain material greater than 25 mm in size, such as stones and clods.

Imported topsoil shall not have contaminants that adversely affect plant growth.

Topsoil shall not be from swamps or muskeg areas, unless specified in the Contract Documents.

Topsoil shall meet the following physical property requirements or as specified the Contract Documents:

a) Have an organic content between 7 and 11% by weight, according to ASTM D2974; and

b) Have a pH from 6.0 to 8.0 according to ASTM D4972.

802.07 CONSTRUCTION

802.07.01 Stockpiling Topsoil

Topsoil shall be removed, stockpiled, and managed as specified in the Contract Documents.

Stockpiles shall not exceed 3 m in height.

Stockpiles shall be constructed neatly with uniform surfaces. When required, the top surface shall be dished.

Stockpiles shall be protected from erosion by covering with tarps or geotextile according to OPSS 1860 to prevent soil erosion and contamination by weeds during storage. Alternatively, topsoil stockpiles can be stabilized by temporarily establishing groundcover vegetation composed of non-invasive species by application of seed according to OPSS 804. Mounds shall be completely surrounded by sediment barriers or compost filter socks according to OPSS 805.

802.07.02 Preparation for Topsoil

Areas where topsoil is to be placed shall be graded according to OPSS 206. The surface shall be scarified to a depth of 50 to 100 mm. It shall be free of all vegetation, debris, and stones which would not be covered by the depth of topsoil specified in the Placement of Topsoil subsection.

These areas shall be maintained in the condition described above until the topsoil is placed.

802.07.03 Placement of Topsoil

Topsoil shall be tested 15 Business Days before placement for the physical quality requirements listed in the Topsoil subsection.

Topsoil shall be placed to a uniform depth of 150 mm on areas specified in the Contract Documents and up to the subgrade elevation on the roadway front slope.

Soil from swamps or muskeg areas, when used in place of topsoil, shall be placed according to the Contract Documents to a uniform depth of 150 mm, with no woody material protruding more than 50 mm above the surface.

802.07.04 Compaction of Topsoil

Compaction of the topsoil, if required, shall not exceed 85% of its maximum dry density, according to LS-706.

802.07.05 Quality Control

802.07.05.01 Compaction Testing of Topsoil

Compaction testing shall be based on material placed and compacted in the work on a Lot-by-Lot basis according to Table 1.

Compaction acceptance shall be according to the Acceptance of Compaction subsection.

802.07.06 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

802.08 QUALITY ASSURANCE

802.08.01 General

A laboratory designated by the Owner may carry out QA testing for purposes of ensuring that the topsoil used in the Work is according to the requirements of this specification. Test results shall be forwarded to the Contractor, as they become available.

The Owner shall be responsible for all costs associated with testing for QA purposes, unless otherwise specified in this specification.

802.08.02 Properties of Topsoil

A minimum of one random duplicate sample of surface soil shall be taken from each Lot, according to the Lot schedule shown in Table 1.

One portion of the duplicate sample representing each Lot shall be tested for the requirements listed in the Topsoil clause.

The Lot of topsoil shall be deemed to be acceptable if all of the test results for the sample representing that Lot meet all applicable requirements of this specification.

If QA test results do not meet all of the requirements of this specification, then the entire Lot shall be rejected and replaced; the Contractor may submit a proposal for remediation or for use of the topsoil, subject to the approval of the Owner.

802.08.03 Acceptance of Compaction

Acceptance testing for compaction of topsoil shall be conducted in Lots according to Table 1, according to OPSS 501, for earth, with the exception of the following:

a) Control strips shall not be used to establish target densities; and

b) A Lot shall be considered acceptable for compaction, if:

   i. The mean percent compaction of the individual test results for the 4 sublots is between 80 and 85%; and
   ii. No more than two individual test results are less than 78% or greater than 87%; of the soil's maximum dry density, according to LS-706, and tested according to OPSS 501.

802.08.04 Referee Testing

Referee testing may be invoked for one or more physical property attributes by submitting a written request to the Contract Administrator, within 5 Business Days following notification that a sample representing a Lot of topsoil does not meet the requirements of this specification.

Referee testing shall be carried out, as specified elsewhere in the Contract Documents. The retained duplicate QA samples shall be used for referee testing.

All referee test results for each Lot shall replace the respective QA test results for acceptance of the applicable Lot and those results shall be binding on both the Owner and the Contractor.

If a Lot is not accepted, based on the referee test results, then the Contractor shall be responsible for the cost of the referee testing of that Lot, at the rates specified in the Contract Documents.

In all other cases, the Owner shall bear the cost of the referee testing.

802.09 MEASUREMENT FOR PAYMENT

802.09.01 Actual Measurement

802.09.01.01 Topsoil from Stockpiles

Measurement shall be by volume in cubic metres of topsoil placed from a stockpile.

802.09.01.02 Topsoil, Imported

Measurement shall be by volume in cubic metres of topsoil imported and placed.

802.10 BASIS OF PAYMENT

802.10.01 Topsoil

Rejected material shall not be used and shall be removed and replaced, at no additional cost to the Owner.

802.10.02 Compaction

Any Lot that does not meet the requirements, shall be scarified and compacted to meet the requirements listed in Acceptance of Compaction subsection b), at no additional cost to the Owner.

802.10.03 Preparation for Topsoil - Item

Payment at the Contract price for the above item shall be full compensation for all labour, Equipment, and Material to do the work.

Payment for this item shall be on surfaces graded under a previous Contract that require preparation for topsoil.

There is no payment for this item on surfaces constructed on this Contract.

802.10.04 Topsoil from Stockpiles - Item

Payment at the Contract price for the above item shall be full compensation for all labour, Equipment, and Material to do the work.

802.10.05 Topsoil, Imported - Item

Payment at the Contract price for the above item shall be full compensation for all labour, Equipment, and Material to do the work.

TABLE 1
Lot Schedule for Sampling and Testing of Topsoil

Quantity of Topsoil Used (m^3)	Quantity of Topsoil Used (m^2)	Minimum Lot Schedule
< 100	< 670	Sampling and Testing Shall be Carried out at the Discretion of the Contract Administrator
100 - 500	670 - 3,330	One Lot
> 501 - 1,000	> 3,331 - 6,670	Two Lots
> 1,001	> 6,671	One Lot per 1000 m^3

Appendix 802-A, November 2019
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

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Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Topsoil from swamps or muskeg areas. (802.05.01)

- Topsoil requirements in natural areas where pH and/or organic content may fall outside required ranges. (802.05.01)

- Topsoil removal and stockpiling areas. (802.07.01)

- Topsoil placement areas. (802.07.03)

- Topsoil placement areas from swamps or muskeg areas. (802.07.03)

- Rates of the referee testing. (802.08.04)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

Note: The MUNI implemented in April 2018 replaces OPSS 803 COMMON, November 2015 with no technical content changes.

CONSTRUCTION SPECIFICATION FOR SODDING

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803.09 **MEASUREMENT FOR PAYMENT**

803.10 **BASIS OF PAYMENT**

APPENDICES

803-A **Commentary**

803.01 SCOPE

This specification covers the requirements for sodding.

803.01.01 Specification Significance and Use

This specification has been developed for use in provincial- and municipal-oriented Contracts. The administration, testing, and payment policies, procedures, and practices reflected in this specification correspond to those used by many municipalities and the Ontario Ministry of Transportation.

Use of this specification or any other specification shall be according to the Contract Documents.

803.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

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Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

803.02 REFERENCES

When the Contract Documents indicate that provincial-oriented specifications are to be used and there is a provincial-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.PROV, unless use of a municipal-oriented specification is specified in the Contract Documents. When there is not a corresponding provincial-oriented specification, the references below shall be considered to be to the OPSS listed, unless use of a municipal-oriented specification is specified in the Contract Documents.

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 802 Topsoil

Nursery Sod Growers Association of Ontario

Specifications, Classifications and Use of Turfgrass Sod for Ontario

Federal Statute

Fertilizers Act (R.S., 1985, c. F-10)

803.05 MATERIALS

803.05.01 Sod

Sod shall be a Commercial Grade Turfgrass Nursery Sod, either Kentucky Bluegrass or Kentucky Bluegrass/Fine Fescue as specified in the Contract Documents and according to the Specifications, Classifications and Use of Turfgrass Sod for Ontario.

Sod shall be seeded and established in nursery sod fields as a turfgrass sod. Sod shall be uniform in texture, and in good healthy condition with no sign of decay. There shall be no more than 5 broadleaf weeds per 40 m^2 of sod and up to 20% non-specified grass seed. Sod shall be of sufficient density that no surface soil is visible. The grass height shall be 30 mm minimum and 70 mm maximum.

The soil portion of the sod shall be a good mineral type soil with a thickness of 10 mm minimum and 15 mm maximum. Each sod piece shall be well permeated with roots. Individual sod pieces shall be in such condition so that each may be lifted, rolled, transported, and placed without breaking or tearing and without loss of soil under normal handling conditions.

Sod shall contain sufficient moisture to maintain its vitality during transportation and placement.

803.05.02 Stakes

Stakes for fastening sod to the earth grade shall be a minimum 150 mm in length.

803.05.03 Fertilizer

Fertilizer shall be according to the Canada Fertilizers Act. Fertilizer shall be supplied in bags bearing the manufacturer's label indicating net weight and guaranteed analysis.

Fertilizer shall be in granular form, dry, free flowing without lumps. Fertilizer shall be supplied with a minimum analysis of 16% nitrogen, 3% phosphorus, and 15% potash. The guaranteed analysis ratio shall be 3-1-2.

The total nitrogen component of the fertilizer shall be a minimum 30% water insoluble nitrogen (controlled, slow release nitrogen) by weight.

803.05.04 Water

Water shall not have contaminants or impurities that would adversely affect the germination and growth of vegetation.

803.07 CONSTRUCTION

803.07.01 Operational Constraints

Sodding shall not commence until the surface preparation has been approved in writing by the Contract Administrator.

Sodding shall commence within 7 Days of surface preparation.

The Contractor shall maintain the surface and control erosion until the sod is in place.

Sod shall not be placed when in a frozen condition, under adverse field conditions such as high wind, frozen soil or soil covered with snow, ice, or standing water.

803.07.02 Surface Preparation for Sodding

Where topsoil is specified, it shall be according to OPSS 802.

At the time of sodding, all surface areas designated for sodding shall be free of erosion and shall have a fine graded uniform surface. The surface shall be uniformly cultivated to a minimum depth of 50 mm and shall not have surface materials greater than 25 mm in size, such as stones and clods and weeds or other unwanted vegetation.

Surface litter and debris shall be removed immediately prior to sod placement.

803.07.03 Fertilizer Application

Fertilizer shall be applied uniformly to the surface area designated for sodding, a maximum of 48 hours prior to sod placement, at the rate specified on its bag by the manufacturer.

803.07.04 Placement of Sod

Sod shall be placed in locations and as specified in the Contract Documents. Voids shall not be left between the soil portion of the sod and the underlying ground surface. Sod shall be securely placed lengthwise across the face of slopes and parallel to the centreline of ditches. End joints of adjacent sod pieces shall be staggered. The edges of adjacent sod pieces shall be placed tightly against one another without overlapping. Sod shall be countersunk to existing grade level at all edges. Joints shall be tamped to a uniform surface. Sod shall be placed up to the subgrade elevation on the roadway front slope. Where required, sod should be staked to the grade to avoid movement.

Sod shall not be separated from its mineral soil base and not damaged during transportation, handling, and placement.

803.07.05 Maintenance of Completed Sodding

Sod shall be maintained for 30 Days following completion of placement. During this period, the placed sod shall be kept healthy, actively growing, and green in leaf colour. This requirement shall be suspended during the winter dormant period shown in Table 1.

803.07.06 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

803.08 QUALITY ASSURANCE

803.08.01 Performance Measure

At the end of the 30-Day maintenance period, the Contract Administrator shall make an inspection of all placed sod. The condition of the sod shall be as specified in the Maintenance of Completed Sodding subsection. The sod shall be in the same location as originally placed and shall not have moved, eroded, slipped, or sloughed. Sod shall show evidence of rooting into the underlying soil. The sod shall be of sufficient density that no surface soil is visible and there shall be no competitive growth, beyond that specified in the Sod subsection, emerging from the sod or from between the sod joints.

803.08.02 Acceptance

When the work does not meet the requirements specified herein, the Contract Administrator shall notify the Contractor in writing, and the Contractor shall re-apply the specified materials according to this specification within 14 Days of receiving the notification.

The Contractor shall maintain the site and control erosion as specified in this specification until the sod has been replaced.

Replaced sod shall be subject to the requirements specified herein and to a further maintenance period of 30 Days.

803.09 MEASUREMENT FOR PAYMENT

803.09.01 Actual Measurement

803.09.01.01 Sod

Measurement shall be by area in square metres following the contours of the ground.

803.09.01.02 Plan Quantity Payment

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clause under Actual Measurement.

803.10 BASIS OF PAYMENT

803.10.01 Sod - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

TABLE 1
Winter Dormant Period

SOUTHWESTERN ONTARIO	SOUTHERN ONTARIO	NORTHERN ONTARIO
That area of Ontario south of a line joining Grand Bend and Clarkson	That area of Ontario between the northern and southern boundaries of Southwestern Ontario and Northern Ontario respectively	That area of Ontario north of a line joining Waubaushene, Severn Bridge, Bancroft and Ottawa
Nov 15 to April 15 inclusive	Nov 1 to April 30 inclusive	Oct 15 to May 15 inclusive

Appendix 803-A, November 2010
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

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Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- The use of either Kentucky Bluegrass sod or a Kentucky Bluegrass/Fine Fescue sod. (803.05.01)

- Location of sod. (803.07.04)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

None

CONSTRUCTION SPECIFICATION FOR SEED AND COVER

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804.08 **QUALITY ASSURANCE**

804.09 **MEASUREMENT FOR PAYMENT**

804.10 **BASIS OF PAYMENT**

APPENDICES

804-A **Commentary**

804.01 SCOPE

This specification covers the requirements for seeding with either rolled erosion control products or hydraulically applied erosion control products.

804.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

804.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

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The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

804.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Ministry of Transportation Publication

Seeding and Cover Quality Assurance Visual Inspection Field Guide

Canadian and Provincial Statutes

Canada Fertilizers Act (R.S., 1985, c. F-10)
Canada Seeds Act (R.S., 1985, c. S-8)

804.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Cover means any approved or specified material such as rolled erosion control products, (i.e., blankets) or hydraulically applied erosion control products (i.e., hydraulic mulch, bonded fibre matrix, fibre reinforced matrix) applied at the time of seeding to provide temporary erosion control and protection of the germinating seed.

Cultivate means to prepare and work the soil with agricultural implements to provide a specified depth of loose, friable soil as a suitable medium to germinate seed.

Fibre Reinforced Matrix (FRM) means any approved or specified hydraulically applied erosion control product applied to provide cover, in which mechanical and chemical bonding techniques including water resistant tackifiers and flocculants are used to interlock fibres together to form a matrix that bonds to the soil surface.

Seeded Earth Area means the prepared earth area that has received the applied seed and fertilizer.

Uniform, Cohesive Mat means an application of cover that is unvarying in consistency and when all of the cover material particles are consolidated and adhere together to produce a solid layer that protects the seeded earth area from heat and adverse environmental conditions, yet allows moisture to percolate into the underlying soil.

Waterbody means any permanent or intermittent, natural or constructed body of water including lakes, ponds, wetlands and watercourses, but does not include sewage works as defined in the Ontario Water Resources Act.

804.04 DESIGN AND SUBMISSION REQUIREMENTS

804.04.01 Submission Requirements

A legible, valid Certificate of Seed Analysis from a seed testing laboratory approved by the Canadian Food Inspection Agency for all single seed species and all seed mixtures to be used on the Contract shall be provided to the Contract Administrator 24 hours prior to any seeding operations.

804.05 MATERIALS

804.05.01 Seed

804.05.01.01 Grade Standards

All seed supplied, either as single seed species or as a seed mix shall comply with the provisions of the Canada Seeds Act and Regulations and the grade standards for that particular seed type.

Birdsfoot Trefoil mix shall contain only certified Blue Tag Leo Birdsfoot Trefoil.

804.05.01.02 Certificate of Seed Analysis

The Certificate of Seed Analysis shall stipulate the seed supplier's lot designation numbers.

Test results from the Certificate of Seed Analysis shall specify germination and purity for each seed species of the mix, as well as the seed mix composition expressed as a percentage of each seed species by mass for each seed mix specified in the Contract Documents. Test results shall comply with the values shown in Table 1 for the various seed mixes.

804.05.01.03 Seed Packaging, Labelling, and Storage

All seed and seed mixes shall be in the original factory sealed package with the original legible label securely attached.

Labelling shall be in accordance with the requirements of the Canada Seeds Act and Regulations. Each package shall be labelled to show:

a) The name and address of the seed supplier.

b) The name of the seed mix and the various individual seed species that comprise the seed mix and the percentage by mass of each.

c) The grade of the seed or seed mix.

d) The supplier's lot designation number corresponding to the Certificate of Seed Analysis.

e) Mass in kilograms of the seed mix.

f) The inoculant type, strain, and expiry date.

All seed and inoculant shall be stored in cool, dry locations until use. Inoculant is only required for seed mixes containing Crown Vetch or Birdsfoot Trefoil.

804.05.01.04 Permanent Seed Mixes

Permanent seed mixes shall be as specified in the Contract Documents and as shown in Table 1.

804.05.02 Annual Nurse Crop Seed

Nurse crop seed shall be either Fall Rye Grain or Winter Wheat Grain, unless otherwise approved by the Contract Administrator.

804.05.03 Fertilizer

Fertilizer shall comply with the provisions of the Canada Fertilizers Act and Regulations. Fertilizer shall be supplied in original factory sealed bags bearing the manufacturer's original label indicating mass and analysis. All fertilizer shall be in granular form being dry, free flowing, free from lumps, and with an analysis shown in Table 2.

804.05.04 Cover

804.05.04.01 Straw Mulch

Straw mulch shall be oat or wheat straw. Straw shall be supplied in bales, dry, and free of weeds and other foreign materials.

804.05.04.02 Straw Mulch Tackifiers

Organic straw mulch tackifiers may include wood and fibre paper mulch or guar and starch based tackifiers. Asphalt based tackifiers are not acceptable.

804.05.04.03 Hydraulic Mulch

Hydraulic mulch shall be capable of dispersing rapidly in water to form a homogeneous slurry and remain in such a state when agitated or mixed with other specified materials. When applied, hydraulic mulch shall be capable of forming a uniform, cohesive mat. Hydraulic mulch shall not inhibit growth or germination of the seed mix. Hydraulic mulch shall be dry, free of weeds and other foreign materials, and shall be supplied in factory sealed packages bearing the manufacturer's label indicating the product name and mass.

804.05.04.04 Bonded Fibre Matrix (BFM) and Fibre Reinforced Matrix (FRM)

BFM and FRM shall be a hydraulically applied, 100% biodegradable product, which after application is capable of adhering to the soil. In a dry state, BFM shall be comprised of not less than 70% by weight of long stranded wood fibres held together by organic or mineral bonding agents or both. The hydrated BFM shall form a viscous material that creates a high strength, porous, and erosion-resistant uniform, cohesive mat, when applied and dried. The bonding agent shall not dissolve or disperse upon re-wetting. BFM shall not inhibit the germination or growth of plant material.

804.05.04.05 Erosion Control Blanket (ECB)

ECB shall be of a consistent thickness with a 100% biodegradable even fibre distribution. The ECB shall be covered on top with a biodegradable and photodegradable plastic mesh. ECB may also be sewn together with cotton thread. ECB shall be supplied in a dry rolled mat protected with an outer waterproof wrap bearing the manufacturer's original label indicating product name and application instructions.

804.05.05 Erosion Control Blanket (ECB) Staples

ECB staples shall be u-shaped, constructed of wire with a diameter of at least 2.5 mm with legs at least 150 mm long and 25 mm apart.

804.05.06 Water

Water shall be free of any contaminants or impurities that would adversely affect the germination and growth of vegetation.

804.06 EQUIPMENT

804.06.01 Hydraulic Seeder and Mulcher

The hydraulic seeder and mulcher shall be capable of mixing the materials into homogeneous slurry and maintaining the slurry in a homogeneous state until it is applied. The discharge pumps and gun nozzles shall be capable of applying the materials uniformly over the specified area. A hose extension for the hydraulic seeder and mulcher shall be on site and available for use for areas outside of the range of the gun nozzle.

804.06.02 Straw Mulch Blower

The straw mulch blower shall be capable of separating straw from the bales without chopping it into short lengths and applying the straw mulch in a uniform, cohesive mat.

When tackifiers are used, the straw mulch blower shall be capable of applying straw mulch and tackifiers simultaneously. The straw mulch blower shall be equipped with a minimum of two nozzles located inside the end of the blower pipe to coat the straw with the tackifier. Crimping may also be used to secure the straw mulch.

804.06.03 Cyclone Spreader

The cyclone spreader shall be capable of distributing seed and fertilizer uniformly in a dry state.

804.07 CONSTRUCTION

804.07.01 Operational Constraints

The seeding operation shall not commence until the Contract Administrator is in receipt of the Certificate of Seed Analysis for the seed being applied.

The seeding operation shall not commence until the Contract Administrator has approved the surface preparation, layout of permanent seed mix locations, and different cover types.

Seed and cover application or re-application shall not be carried out under adverse weather conditions such as high wind or heavy rain or when field conditions are not conducive to seed germination such as frozen soil or soil covered with snow, ice, or standing water.

The Contractor shall maintain the site and control erosion until final acceptance of the seed and cover.

Seed or cover shall not come in contact with the foliage of any trees, shrubs, or other vegetation, except as specified in the Seeding subsection. Seed or cover shall not come in contact with waterbodies.

BFM or FRM shall be installed by a Contractor certified and trained by the manufacturer in the proper mixing and installation of the product. To ensure a suitable drying and curing period, BFM and FRM shall not be applied when rainfall is expected, during rainfall, or immediately after rainfall.

804.07.02 Surface Preparation for Seeding

The surface to be seeded shall be prepared not more than 7 Days prior to the seeding operation.

At the time of seeding, all surface areas designated for seeding shall have a fine-graded uniform surface and shall exhibit no evidence of erosion. The surface shall be uniformly cultivated to a minimum depth of 50 mm and shall not have surface stones greater than 25 mm in diameter, foreign material, and weeds or other unwanted vegetation.

804.07.03 Layout

The locations and limits of the different permanent seed mixes and different cover types as specified in the Contract Documents shall be staked out on the ground surface.

804.07.04 Seeding

804.07.04.01 Application Rates for Seed, Fertilizer, and Water

Application rates for primary seed, nurse crop seed, and fertilizer shall be as shown in Table 2.

804.07.04.02 Seed and Fertilizer Application

Seed and fertilizer shall be applied prior to the application of cover.

Seed, fertilizer, and water shall be thoroughly mixed in the hydraulic seeder and mulcher into a homogeneous water slurry. When thoroughly mixed, the water slurry shall be applied to the prepared earth areas by the nozzle sprayer or extension hose.

The Contractor shall ensure that the seeding equipment is calibrated to provide the coverage shown in Table 2. The Contractor shall ensure there is a uniform dispersal of the mixed material over the entire area designated for seeding and that the spray does not dislodge soil or cause erosion.

Seed and fertilizer may also be applied separately by a cyclone spreader. Seeding shall overlap the adjoining ground cover by 300 mm.

804.07.05 Cover Applications

All cover materials shall be applied as a separate operation immediately following the application of seed and fertilizer.

The Contractor shall ensure that the hydraulic seeder and mulcher are properly calibrated to provide the coverage as specified for each of the hydraulically applied cover materials.

804.07.05.01 Straw Mulch Application

Straw mulch shall be applied to form a uniform, cohesive mat over 100% of the seeded earth area. The straw mulch shall be applied to a minimum depth of 25 mm and a maximum depth of 50 mm measured at the time of application.

804.07.05.02 Hydraulic Mulch Application

Hydraulic mulch shall be applied at the rate of 2,000 kg of dry product per 10,000 m^2. Hydraulic mulch shall be thoroughly mixed with water into a homogenous slurry.

When thoroughly mixed, the hydraulic mulch slurry shall be applied to the seeded earth areas by nozzle sprayer or extension hose. The mixed material shall be evenly dispersed over the entire seeded earth area to form a uniform, cohesive mat. The spray shall not dislodge soil or cause erosion.

804.07.05.03 Bonded Fibre Matrix (BFM) and Fibre Reinforced Matrix (FRM) Application

BFM and FRM shall be applied at a minimum rate of 3,700 kg of dry product per 10,000 m^2. BFM or FRM shall be mixed with water in a hydraulic seeder and mulcher at a rate of 20-30 kg of dry product to 500-600 litres of water to form a homogeneous slurry.

When thoroughly mixed, the BFM or FRM slurry shall be applied to the seeded earth areas by nozzle sprayer or extension hose. The BFM or FRM slurry shall be evenly dispersed in successive applications from different directions over the seeded earth area to form a uniform, cohesive mat. The spray shall not dislodge soil or cause erosion.

804.07.05.04 Erosion Control Blanket (ECB) Application

(ECB) shall be placed and stapled into position according to the manufacturer's installation instructions over the entire designated surface area. Blankets shall be installed in direct contact with the ground surface to form a uniform, cohesive mat over the seeded earth area. The Contractor shall ensure that the ECB is anchored to the soil and that tenting of the ECB does not occur.

On slopes, the uppermost edge of the ECB shall be anchored in a 150 mm wide by 150 mm deep trench when the ECB cannot be extended and anchored over the crest of the slope. The trench shall be backfilled with earth and compacted.

804.07.06 Cleanup

When seed and cover materials are applied to the foliage of trees, shrubs, other susceptible plant material, or waterbodies, the Contractor shall immediately remove the seed and cover materials from the areas and wash the areas with clean water.

When seed and cover materials are applied to areas or objects other than those designated, the Contractor shall remove the seed and cover materials.

804.07.07 Management of Excess Material

Management of excess material shall be as specified in the Contract Documents.

804.07.08 Protection of Waterbodies and Waterbody Banks

Protection of waterbodies and waterbody banks shall be as specified in the Contract Documents.

804.08 QUALITY ASSURANCE

804.08.01 Performance Measure

The Certificate of Seed Analysis shall be reviewed by the Contract Administrator to ensure compliance with the values shown in Table 1.

All seeded areas shall be inspected by the Contract Administrator using the Seeding and Cover Quality Assurance Visual Inspection Field Guide to ensure compliance with this specification at 30, 60, and 90-Day periods following the seeding and Cover operation.

At the 30-Day inspection within the seeded area:

a) The applied cover shall be visually intact and shall form a uniform, cohesive mat.

b) Germination of the nurse crop shall be visually evident.

At the 60-Day inspection within the seeded area:

a) The nurse crop shall be evident at mature height in an evenly dispersed, uniform cover.

b) Germination of the specified permanent seed species shall be visually evident in an evenly dispersed uniform cover.

c) There shall not be any significant bare areas, both in terms of quantity and size.

d) Non-seeded, non-specified vegetation shall not exceed 20% of the seeded earth area.

At the 90-Day inspection within the seeded area:

a) The specified permanent seed species shall be at an average height of 50 mm in an evenly dispersed, uniform cover.

b) There shall not be any significant bare areas, both in terms of quantity and size.

c) Non-seeded, non-specified vegetation shall not exceed 20% of the seeded earth area.

Inspections shall not be made during the winter dormant period or when site conditions prohibit a visual field inspection. The timing intervals between inspections shall be suspended during the winter dormant period shown in Table 3.

804.08.02 Failure to Meet Performance Measure

If the values in the Certificate of Seed Analysis for the seeds supplied do not meet the values for seed germination, seed purity, and weed seed content shown in Table 1, the seed lot shall not be approved for use on the Contract and the Contractor shall supply a new seed lot and a new Certificate of Seed Analysis for approval prior to seeding.

If the values in the Certificate of Seed Analysis for the seeds supplied do not meet the values for seed species composition shown in Table 1, the Contractor shall supply a legible, valid copy of the seed mixing sheet from the seed supplier for approval by the Contract Administrator prior to seeding.

If the completed work does not meet the performance measures of the 30-Day inspection, the Contract Administrator shall document the failed areas, notify the Contractor of those areas, and re-inspect at the 60-Day inspection.

If the completed work does not meet the performance measures of the 60-Day inspection, the Contract Administrator shall notify the Contractor in writing of the failed areas. The Contractor shall re-apply the specified material in accordance with this specification within 14 Days of receiving the notification. The Contract Administrator shall re-inspect the seeded area at the 90-Day inspection.

If the completed work does not meet the performance measures of the 90-Day inspection, the Contract Administrator shall notify the Contractor in writing of the failed areas. The Contractor shall re-apply the specified material in accordance with this specification within 14 Days of receiving the notification. The Contract Administrator shall re-inspect the seeded area 30 Days after re-application of material.

Inspections and re-application of material shall continue, as outlined in the 90-Day inspection clause above, until the seeded area has been accepted.

All replaced seed and cover shall be subject to the Quality Assurance section of this specification.

804.08.03 Dispute Resolution

Dispute resolution only applies to the germination and growth of the permanent seed mix species.

Disputes arising from the performance measure evaluation shall be settled through referee testing using an actual live seedling count of the specified permanent seed mix species within the seeded earth area.

An independent consultant with experience in herbaceous plant identification shall perform the referee testing. Both parties shall agree on the selection of the independent consultant and both parties shall be bound by the consultant's evaluation.

The actual count shall be based on minimum germination requirements and minimum levels of acceptability to meet industry standards and federal legislation governing the testing, inspection, quality, and sale of seed.

To determine the number of seeds per unit of weight, published standard industry lists shall be referenced. When these lists show a range in the number of seeds per unit of weight, the mid-range number shall be used. When there is a difference in the estimated number of seeds by weight from one industry standard list to another, the lower figure shall be used.

To determine the germination rate for each seed species, the number of seeds per unit of weight is factored by the minimum germination rate of 70% in accordance with the Canada Seeds Act. A further 25% reduction is allowed to account for variation in seeding application, seedbed quality, seedbed preparation, and area cover.

The Contractor and the Owner may agree to use a simplified analysis, when instead of counting each seedling of each individual seeded perennial species of the mix, only the total number of seedlings of the mix is counted. If the parties cannot agree to the simplified analysis, the default method is a seedling count of each seeded perennial species.

The field inspection to determine the number of live plant seedlings should only be performed after the 90-Day inspection and when the seedlings reach an identifiable and measurable size.

The sampling procedure should be randomized over an area that both parties agree is representative of the seeded Contract. The selection and evaluation process is as follows:

a) Select a representative area from the average seeded areas, eliminating the thinnest and thickest growth areas from the analysis.

b) Measure its length and width. Use a random numbers table to generate five sets of X and Y axis coordinates from the area.

c) Each axis coordinate is a sampling point. A sampling plot, or quadrat, is set out in a 200 x 1,000 mm plot with the axis coordinate becoming the lower right-hand corner of each quadrat.

d) Each quadrat is divided into 20 sub-sampling units, each being 100 x 100 mm.

e) The sub-sampling units are numbered from 1 to 20.

f) Using a random numbers table, two of the twenty sub-sampling units are randomly selected.

g) Live seedlings of each individual seeded perennial species of the mix are counted in the selected sub- sampling units to determine actual plant densities.

h) An average seedling density per seeded perennial species, expressed as the number of seedlings per square metre is generated for each sampling plot or quadrat, based on the data from the two selected sub-sampling units.

i) The procedure is repeated for the four other sampling points.

j) The average number of seedlings per square metre for each of the seeded perennial species generated from the five sampling points is evaluated against the minimum industry standard benchmark for the seeded mix.

If the results of the referee testing prove that the seed and cover is unacceptable in meeting the minimum industry standard for germination, the Contractor shall then re-apply seed and cover in accordance with this specification to all areas under dispute. In addition, the Contractor shall be responsible for all costs associated with the dispute resolution process.

If the results of the referee testing prove that the seed and cover is acceptable in meeting the minimum industry standard for germination, the Owner shall then be responsible for all costs associated with the dispute resolution process.

804.09 MEASUREMENT FOR PAYMENT

804.09.01 Actual Measurement

804.09.01.01 Seed and Mulch

Seeding and mulch measurement shall be in square metres following the contours of the ground without any allowance for overlap.

804.09.01.02 Seed and Erosion Control Blanket

Seeding and erosion control blanket measurement shall be in square metres following the contours of the ground without any allowance for overlap.

804.09.01.03 Seed and Bonded Fibre Matrix (BFM) or Fibre Reinforced Matrix (FRM)

Seed and BFM or RFM measurement shall be in square metres following the contours of the ground without any allowance for overlap.

804.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

804.10 BASIS OF PAYMENT

804.10.01 Seed and Mulch - Item
Seed and Erosion Control Blanket - Item
Seed and Bonded Fibre Matrix or Fibre Reinforced Matrix - Item

Payment at the Contract price for the above tender items shall be full compensation for all the labour, Equipment, and Material to do the work.

TABLE 1
Permanent Seed Mixes and Seed Certificate Analysis Values

Permanent Seed Mix	Grade Name	Minimum Seed Germination %	Minimum Seed Purity %	Maximum Weed Seed %	Seed Mix %	Seed Species Composition %
Standard Roadside Mix	**Canada #1 Lawn Grass Seed Mixture**	**70**	**85**	**0.5**		
Creeping Red Fescue: *Festuca rubra*					50	50 to 60
Kentucky Bluegrass: *Poa pratensis*					10	25 to 30
Perennial Ryegrass: *Lolium perrenne*					35	12 to 18
White Clover: *Trifolium repens*					5	2 to 4
Crown Vetch Mix	**Common #1 Forage Mixture**	**75**	**N/A**	**3.0**		
Creeping Red Fescue: *Festuca rubra*					66	62 to 70
Crown Vetch: *Coronilla varia* inoculated seed					34	30 to 38
Birdsfoot Trefoil Mix	**Common #1 Forage Mixture**	**75**	**N/A**	**3.0**		
Creeping Red Fescue: *Festuca rubra*					66	62 to 70

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Permanent Seed Mix	Grade Name	Minimum Seed Germination %	Minimum Seed Purity %	Maximum Weed Seed %	Seed Mix %	Seed Species Composition %

Continues From Previous Page

Birdsfoot Trefoil 'Leo': *Lotus corniculatus* 'Leo inoculated seed					34	30 to 38
Salt Tolerant Mix	**Canada #1 Ground Cover Mixture**	**70**	**85**	**3.0**		
Tall Fescue: *Festuca arundinacea*					25	20 to 30
Fults Alkali Grass: *Puccinellia distans*					20	15 to 25
Creeping Red Fescue: *Festuca rubra*					25	15 to 25
Perennial Ryegrass: *Lolium perrenne*					20	15 to 25
Hard Fescue*:* *Festuca trachyphylla*					10	10 to 15
Lowland Mix	**Common #1 Forage Mixture**	**75**	**N/A**	**3.0**		
Creeping Red Fescue: *Festuca rubra*					35	40 to 50
Brome Grass: *Bromus nerres*					25	20 to 30
Kentucky Bluegrass: *Poa pratensis*					10	10 to 20

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Permanent Seed Mix	Grade Name	Minimum Seed Germination %	Minimum Seed Purity %	Maximum Weed Seed %	Seed Mix %	Seed Species Composition %

Continues From Previous Page

Birdsfoot Trefoil 'Leo': *Lotus corniculatus* 'Leo' inoculated seed					5	3 to 7
White Clover: *Trifolium repens*					5	3 to 7
Perennial Ryegrass: *Lolium perrenne*					20	3 to 7
Acidic Soil Mix	**Common #1 Forage Mixture**	**75**	**N/A**	**3.0**		
Birdsfoot Trefoil 'Leo', *Lotus corniculatus* 'Leo' inoculated seed					30	30 to 40
Red Top: *Agrostis gigantea*					10	20 to 30
Tall Fescue: *Festuca arundinacea*					15	15 to 20
Creeping Red Fescue: *Festuca rubra*					30	7 to 12
Hard Fescue: *Festuca trachyphylla*					5	3 to 7
Alsike Clover: *Trifolium hybridum*					5	3 to 7
Red Clover: *Trifolium pratense*					5	3 to 7

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Permanent Seed Mix	Grade Name	Minimum Seed Germination %	Minimum Seed Purity %	Maximum Weed Seed %	Seed Mix %	Seed Species Composition %

Continues From Previous Page

Northern Ontario Mix	**Common #1 Forage Mixture**	**75**	**N/A**	**3.0**		
Red Top: *Agrostis gigantea*					10	35 to 40
Timothy: *Phleum pratense*					10	10 to 20
Creeping Red Fescue: *Festuca rubra*					30	10 to 15
Birdsfoot Trefoil: *Lotus corniculatus 'Leo" inoculated seed*					5	6 to 10
Alsike Clover: *Trifolium hybridum*					3	3 to 7
White Clover: *Trifolium repens*					2	3 to 7
Bromegrass: *Bromus nerrer*					20	1 to 5
Hard Fescue: *Festuca trachyphylla*					10	1 to 5
Meadow Fescue: *Festuca pratensis*					10	1 to 5

TABLE 2
Application Rates for Seed and Fertilizer

Permanent Seed Mixes	Permanent Seed Mix Rate kg/10,000 m²	Fertilizer Rate minimum 200 kg/ha			Nurse Crop Rate kg/10,000 m²
		8-32-16	0-46-0	0-0-60	
Standard Roadside Mix	130	350	-	-	60
Crown Vetch Mix	100	350	250	-	60
Birdsfoot Trefoil Mix	100	350	250	-	60
Salt Tolerant Mix	130	350	-	-	60
Lowland Mix	130	350	-	-	60
Acidic Soil Mix	130	350	200	200	60
Old Field Mix	100	350	-	-	60

TABLE 3
Winter Dormant Period

SOUTHWESTERN ONTARIO	SOUTHERN ONTARIO	NORTHERN ONTARIO
That area of Ontario south of a line joining Grand Bend and Clarkson.	That area of Ontario between the northern and southern boundaries of Southwestern Ontario and Northern Ontario respectively.	That area of Ontario north of a line joining Waubaushene, Severn Bridge, Bancroft, and Ottawa.
November 15 to April 15 inclusive	November 1 to April 30 inclusive	October 15 to May 15 inclusive

Appendix 804-A, November 2014
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The following should be specified in the Contract Documents:

- Permanent seed mixes. (804.05.01.04)

The designer may select the appropriate seed mix and cover type application from Tables A-1 and A-2 included in this appendix. The designer may propose new site specific seed mixes to suit existing conditions that require a different seed than those specified.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

APPENDIX TABLE A-1
Permanent Seeding Mix Types

Permanent Seed Mixes	Seed Mix Attributes	Selection Criteria
Standard Roadside Mix	A tested mix of hardy roadside perennial grasses that have performed well in highway situations.	This mix should be the default seed mix for most roadside seeding work.
Crown Vetch Mix	A blend of a hardy legume and a hardy turfgrass. The turfgrass provides control and top growth until the Crown Vetch plants grow and develop after several seasons. Crown Vetch produces a mass of purple flowers in season and is a vigorous ground cover.	This mix is primarily used to revegetate slope areas when erosion and soil fertility may be a problem. There have been some concerns over its ability to spread and crowd out indigenous growth and its non-native status.
Birdsfoot Trefoil Mix	A blend of another hardy legume and a hardy turfgrass. Very similar growth characteristics to the Crown Vetch mix, except a little slower growing, less vigorous, and Trefoil has masses of yellow flowers in season.	As with Crown Vetch, this mix is primarily used to revegetate slope areas when erosion and soil fertility may be a problem. It is hardier in the north than Crown Vetch and is not as aggressive in growth and habit.
Salt Tolerant Mix	The salt tolerant mix is a blend mixture of several turfgrass species with a proven resistance to salt.	The salt tolerance mix should be specified in areas such as medians, shoulder strips, and shoulder ditches, when salt is thought to be in heavier concentrations.
Lowland Mix	The lowland mix was developed with several species of turfgrasses that grow well in low-lying wet areas.	The lowland mix should be specified along waterbody edges in low-lying areas when light seasonal flooding is a possibility.
Acidic Soil Mix	The acidic soil mix was developed to provide adequate vegetative cover on areas of low fertility and high acidity.	The acidic soil mix should be used in areas of low fertility, medium to high acidity, and in the northern areas of the province.
Northern Ontario Mix	This mix is designed to suit the limited topsoil conditions and acidity of Northern Ontario sites.	Old field should be selected when there will be fallow areas left alone with little or no maintenance, no mowing, and the area will be required to be self- sustaining. More suitable in rural areas than urban or suburban.

APPENDIX TABLE A-2
Seeding Cover Application Types

Cover Application Types	Cover Type Attributes	Selection Criteria
Straw	Chopped straw is applied to the seeded area via a straw mulch blower and is coated with a tackifier or crimped to hold it together. A time-tested method of providing cover and protection for germinating seedlings, as well as short-term erosion control.	One of the default cover types. Straw has the advantage of being relatively cheap and providing good coverage. Straw cover application requires another piece of equipment and a labour intensive second application to properly apply the cover material.
Hydraulic Mulch	Hydraulic mulch is a processed fibre of wood, straw, cotton, cellulose pulp, or any combination of these materials. Hydraulic mulches provide a uniform absorptive mat that allows moisture to penetrate into the underlying soil, while providing cover for the germinating seed.	Hydraulic mulch is the other default mulch. It has the advantage of being easy to apply, using the same equipment when applying seed and fertilizer. It is low-cost and low-labour. Hydraulic mulch does not give the same degree of protection to the germinating grass as straw does. During extremes of temperature and moisture, it will not perform as well as straw or other higher levels of erosion control.
Erosion Control Blanket (ECB)	ECBs are a family of products that are supplied in rolls. They are unrolled over the seeded earth area and stapled in place. ECBs provide a higher level of erosion control and protection for germinating seedlings. ECBs are machine woven mats with a variety of materials sandwiched between the two woven layers. Materials can be wood, coco or cotton fibre, straw, or any combination depending upon manufacturer.	ECBs should be specified in the contract preparation stage and not during construction. ECBs are specified on a project when erosion of soil slopes or soil ditches is expected to be a problem. ECBs have an advantage over hydraulic mulch in that the blanket is firmly attached to the underlying soil by staples, it is longer lasting, and provides a superior growth medium for seedlings. It is more expensive and improper installation can result in poor end results leading to surface erosion.
Bonded Fibre Matrix (BFM)	BFM is a hydraulically applied product made of wood, cotton, or cellulose pulp fibres. The fibres are bonded together by various means including mineral bonding agents or organic tackifiers. When applied, the BFM forms a viscous material that upon drying creates a high strength, porous, and erosion resistant mat.	BFMs are applied like hydraulic mulches and have a great similarity to hydraulic mulches, except BFMs have greater erosion resistance and create a thicker, firmer mat. BFMs should be specified when erosion of soil slopes or soil ditches is expected to be a problem and when hydraulic seeders can get access. BFMs are specified in the design stage and have also been substituted for ECBs during construction, although usually at the Contractor's request.
Fibre Reinforced Matrix (FRM)	FRM is a hydraulically applied product made of pasteurized wood fibers, dispersible synthetic fibers, and soil-bonding agents. When applied, the FRM forms a viscous material that dries quickly and locks up within one hour. Upon drying the product provides increased flexibility and loft for impact resistance, air circulation, and moisture retention that promotes seed germination and plant growth.	FRMs are applied like hydraulic mulches and have a great similarity to hydraulic mulches, except differ from BFMs in that they cure within two hours, have superior cover factor and vegetation establishment. The functional longevity is up to 18 months. Due to the thickness, the product provides superior terrain protection, even during hard rains. This product can be used for any slopes, including 1H:1V.

CONSTRUCTION SPECIFICATION FOR TEMPORARY EROSION AND SEDIMENT CONTROL MEASURES

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APPENDICES

805-A **Commentary**

805.01 SCOPE

This specification describes the requirements for the installation, maintenance, and removal of temporary erosion and sediment control measures.

805.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

805.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

805.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 206	Grading
OPSS 517	Dewatering
OPSS 804	Seed and Cover

Ontario Provincial Standard Specifications, Material

OPSS 1004	Aggregates - Miscellaneous
OPSS 1801	Corrugated Steel Pipe Products
OPSS 1840	Non-Pressure Polyethylene Plastic Pipe Products
OPSS 1860	Geotextiles

Canadian and Provincial Statutes

Ontario Water Resources Act, R.S.O. 1990, c. 0.40

Canadian General Standards Board (CGSB)

148.1 No 7.3-92	Methods of Testing Geosynthetics and Geomembranes - Grab Tensile Test for Geotextiles
148.1 No 10-94	Methods of Testing Geosynthetics - Geotextiles - Filtration Opening Size

805.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Diversion Ditch means a temporary channel to intercept and convey overland flow away from areas of disturbed or erodible soil and to minimize erosion of slopes from sheet flow.

Earth means as defined in OPSS 206.

Erosion means the physical removal or detachment of soil particles from an earth surface, followed by the transport of detached particles to another location by the action of a mobile agent including rain, flowing water, wind, equipment and vehicles.

Fibre Roll means an assembled or commercially available flexible, tubular structure that provides sediment control and may provide run-off filtration and includes wattles, filter socks and filter berms.

High Water Level means the highest point on the bank or floodplain of a waterbody where the water level reaches during high flow events or periods.

Riparian Vegetation means vegetation within 30 m of a waterbody.

Sediment means soil particles detached from an earth surface by erosion.

Waterbody means any permanent or intermittent, natural or constructed body of water including lakes, ponds, wetlands and watercourses, but does not include sewage works as defined in the Ontario Water Resources Act.

Waterbody Bank means the slope on or adjacent to a waterbody from the normal water level to the top of slope.

Watercourse means a stream, creek, river, or channel including ditches, in which the flow of water is permanent, intermittent, or temporary.

805.05 MATERIALS

805.05.01 Straw and Straw Bales

Straw shall be either wheat or oat straw.

Straw bales shall be dry and firm, be tied tightly in at least two places, show no evidence of straw or tie decay, and be free of sediment. They shall be of agricultural, rectangular formation and dimensions, as specified in the Contract Documents.

805.05.02 Geosynthetics

805.05.02.01 Geotextile

Geotextile shall be free of holes, tears, and punctures.

805.05.02.02 Silt Fence Geotextile

Geotextile for silt fence shall be according to OPSS 1860, Table 3.

Geotextile for silt fence may be separate from the stakes used to install it as a sediment barrier.

805.05.02.03 Berm Barrier and Rock Flow Check Dam Geotextile

Geotextile for berm barriers and rock flow check dams shall be a woven, Class II geotextile according to OPSS 1860. The filtration opening size (FOS) shall be no greater than 300 μm.

805.05.02.04 Turbidity Curtain Geosynthetic

Turbidity curtain geosynthetics shall have a grab tensile strength of at least 990 N, meeting CAN/CGSB 148.1, No. 7.3 and be one of geotextile or geomembrane.

Geotextile shall be a woven material. The filtration opening size (FOS) shall be no greater than 300 μm, meeting CAN/CGSB 148.1, No. 10.

Geomembrane shall be a low-permeability synthetic material or a geotextile impregnated with elastomeric spray.

805.05.02.05 Filter Bags

Geotextile for filter bags shall be non-woven, polypropylene, Class I according to Table 1 of OPSS 1860 unless otherwise specified in the Contract Documents.

805.05.03 Plastic Sheeting

Plastic sheeting used to wrap berm barriers or other sediment control measures shall be 6 mm polyethylene of maximum available width.

805.05.04 Stakes

Stakes shall be of sufficient strength and length to satisfy control measure installation, performance and maintenance requirements.

805.05.05 Control Measure Support

Control measure support for heavy-duty silt fence barrier shall be a separate product or one bonded to silt fence geotextile and be either plastic snow fence mesh, 0.81 mm diameter galvanized wire mesh or 1.63 mm diameter galvanized steel fence with a 5 cm by 10 cm weave and a 0.91 m height.

When a heavy-duty silt fence barrier is installed using a product manufactured with the control measure support bonded to the geotextile it shall be installed with the geotextile on the upstream side or front of the control measure support.

805.05.05.01 Posts

Posts to support heavy duty wire-backed silt fence barriers shall be metal T-posts. Metal ties shall be used to secure the silt fence to the metal T-posts.

805.05.06 Berm Barriers

Berm barriers shall be constructed using earth, sand, gravel, brush or compost.

805.05.07 Sandbags

Sandbags shall be made from heavy gauge plastic, agricultural burlap, or silt fence geotextile. Heavy gauge plastic shall contain stabilizers or inhibitors resistant to deterioration by ultraviolet radiation. Sandbags shall be filled with clean sand, 19 mm gravel or 6 mm pea gravel, containing no silt or clay.

805.05.08 Fibre Rolls

Fibre rolls shall be of a consistent internal thickness with even fibre distribution throughout the roll.

Fibre rolls shall be covered on the outside with an open-weave, biodegradable and photodegradable mesh or netting that securely contains the fibres within the rolls.

Fibre rolls shall be filled with 100% organic, biodegradable material such as shredded straw, wood fibres or compost and may contain seed.

805.05.09 Turbidity Curtain Hardware

805.05.09.01 Floatation

Turbidity curtain floatation shall be a material that has sufficient buoyancy to provide the curtain with continuous support, and a minimum of freeboard as specified in the Contract Documents.

805.05.09.02 Load Lines

Turbidity curtain load lines shall be 8 mm diameter steel cable or 19 mm diameter nylon or polypropylene rope.

805.05.09.03 Ballast

Turbidity curtain ballast shall be 8 mm steel chain.

805.05.09.04 Anchors

Turbidity curtain anchors shall be mushroom or kedge anchors with a minimum mass of 34 kg for firm mud bottoms or self-burying anchors with a minimum mass of 5 kg for sandy bottoms.

805.05.09.05 Mooring Buoys

Turbidity curtain mooring buoys shall have provision for the mooring line to be securely attached and be sufficiently buoyant to remain afloat under normal load conditions.

805.05.09.06 Mooring Lines

Turbidity curtain mooring lines shall be 19 mm diameter nylon or polypropylene rope.

805.05.09.07 Adjustment Lines

Turbidity curtain adjustment lines shall be 13 mm diameter nylon or polypropylene rope.

805.05.10 Rock

Rock for rock flow check dams shall be according to the requirements for rip-rap and gabion stone according to OPSS 1004.

805.05.11 Corrugated Pipe

Corrugated pipe slope drains shall be non-perforated, corrugated steel pipe according to OPSS 1801 or polyethylene plastic pipe according OPSS 1840. Pipe diameter shall be as specified in the Contract Documents.

805.05.12 End Sections

End sections for the inlet and outlet of slope drains shall be according to OPSS 1801, regardless of the material type of the pipe used.

805.05.13 Erosion Control Blankets

Erosion control blankets for diversion ditches shall be as specified in OPSS 804.

805.07 CONSTRUCTION

805.07.01 Operational Constraints

805.07.01.01 Retention of Riparian Vegetation

The area over which vegetation is removed on site shall affect no more than one third (1/3) of the total woody vegetation in the right-of-way within 30 m of the high water level of any waterbody unless otherwise specified in the Contract Documents.

805.07.01.02 Protection of Stockpiled Materials

All stockpiles of erodible construction materials and excess or surplus materials shall be protected from erosion and sediment transport within 48 hours of being built unless otherwise specified in the Contract Documents.

805.07.01.03 Dewatering

Dewatering effluent shall be controlled to prevent passage of sediment into waterbodies and other sensitive environmental features as specified in the Contract Documents or onto adjacent properties. Discharge of dewatering effluent to sediment traps for dewatering shall be controlled to avoid exceeding trap capacity and to prevent scour and washout.

Discharge of water from sediment traps for dewatering shall be according to OPSS 517.

805.07.01.04 Slope Drains

When slope drains are specified in the Contract Documents, the slope drain and associated berm barrier shall be constructed in the same day.

805.07.01.05 Turbidity Curtains and Cofferdams

Equipment shall not be operated in a waterbody outside a turbidity curtain or cofferdam other than hand held equipment or boats.

805.07.01.06 Construction and Removal of Measures

The construction and removal times for temporary erosion and sediment control measures shall be as specified in the Contract Documents.

805.07.02 Light-Duty Sediment Barriers, General

Light-duty sediment barriers are light-duty straw bale barriers, light-duty silt fence barriers, or light duty fibre roll barriers.

Light-duty sediment barriers shall be constructed as specified in the Contract Documents.

Light-duty sediment barriers shall not be installed in or across waterbodies.

When the Light-Duty Sediment Barriers item is specified in the Contract Documents, any light-duty sediment barriers may be used. When a specific light-duty sediment barrier is specified in the Contract Documents, there shall be no option of substitution for the control measure.

Light-duty sediment barriers shall include protection placed against the downslope side at the low points of the barrier so that any overflow of the barrier is prevented from causing soil scour and erosion.

805.07.02.01 Light-Duty Straw Bale Barriers

Light-duty straw bale barriers shall be constructed as specified in the Contract Documents.

When specified to be installed around catch basins, straw bales shall be placed completely around catch basins and ditch inlets without gaps. When a double row of straw bales is specified in the Contract Documents, the straw bales shall be placed such that the joints between the straw bales of each row are not in-line with the joints of the straw bales of the adjacent row.

Stakes securing the bales shall be driven through the bales without breaking the bale ties or otherwise disturbing bale firmness and shape.

Maintenance shall include the replacement of each bale at intervals not exceeding 45 Days.

805.07.02.02 Light-Duty Silt Fence Barriers

Light-duty silt fence barriers shall be constructed as specified in the Contract Documents.

Light-duty silt fence barriers shall not be used for perimeter control or property line delineation unless specified in the Contract Documents.

Light-duty silt fence barriers shall be installed within a trench excavated along the contour of the ground such that the elevation of the above ground portion of the fence is the same along its entire length except at the ends. Light-duty silt fence barriers shall be installed without breaks or gaps along their entire length. Light-duty silt fence barriers shall only be installed on flat ground with a minimum offset of 2 m from the toe of the slope being protected. When a longer sediment barrier is required, another light-duty silt fence barrier shall be installed as specified in the Contract Documents.

The geotextile shall be attached firmly, without sagging, to the upslope side of the stakes. Stakes shall be spaced to ensure the geotextile remains vertical. Where the geotextile is joined to provide a continuous run, the ends shall be overlapped a minimum of 500 mm and securely fastened to the stakes using cable ties or soft wire at the top of the geotextile only. The geotextile shall be angled upslope at the ends of each run in a “J” pattern and so that the ends are at a higher elevation than the bottom of the run.

When geotextile is supplied without stakes attached, the geotextile shall be installed into the trench in the ground first, the stakes shall be driven into the ground behind the geotextile, and the geotextile shall be attached to the upslope side of the stakes using cable ties or soft wire at the top of geotextile only.

805.07.02.03 Light-Duty Fibre Roll Barriers

Light-duty fibre roll barriers shall be sized and constructed as specified in the Contract Documents.

Light-duty fibre roll barriers shall be installed along the contour of the ground into trenches that have been excavated into the soil perpendicular to the slope face to a depth of approximately one half the roll diameter and width across the width of the slope.

Any rills and gullies shall be filled in where light-duty fibre roll barriers are to be installed. Light-duty fibre roll barriers shall only be installed on flat ground with a minimum offset of 2 m from the toe of the slope being protected. When a longer sediment barrier is required, another light-duty fibre roll barrier shall be installed tightly butted against the first one.

Light-duty fibre roll barriers shall be installed so that their base is in continuous contact with the underlying soil along their entire length without gaps and angled upslope at each end run in a “J” pattern. The ends of adjacent fibre roll segments shall be tightly butted against each other and shall not be overlapped vertically or horizontally.

A metal bar shall be used to make pilot holes perpendicular to the slope face through the centre of the fibre rolls as specified in the Contract Documents. Pilot holes shall also be made at the ends of each fibre roll segment angled towards the next abutting fibre roll to hold adjacent rolls together.

Wooden stakes shall be driven into the pilot holes as specified in the Contract Documents.

Soil excavated from the trenches shall be placed along the upslope side of the fibre rolls and compacted into the front of the trench to minimize possible undermining by runoff.

The soil on the upslope and downslope sides of the fibre rolls shall be seeded according to OPSS 804.

805.07.03 Heavy-Duty Sediment Barriers, General

Heavy-duty sediment barriers are heavy-duty silt fence barriers, heavy-duty wire-backed silt fence barriers, berm barriers, or sandbag barriers.

Heavy-duty sediment barriers shall be constructed as specified in the Contract Documents, without gaps and without undermining to prevent sediment passage through, under, or around the barrier.

When heavy-duty sediment barriers are specified in the Contract Documents, the Contractor has the option to select any of the heavy-duty sediment barriers or any combination of them. When a specific heavy-duty sediment barrier is specified in the Contract Documents, there shall be no option of substitution for the control measure.

Heavy-duty silt fence barriers shall include control measure support placed against the downstream side at the low points of the barrier so that any overflow of the barrier is prevented from causing soil scour and erosion.

805.07.03.01 Heavy-Duty Silt Fence Barriers

Heavy-duty silt fence barriers shall be constructed as specified in the Contract Documents.

Heavy-duty silt fence barriers shall not be used for perimeter control or property line delineation unless specified in the Contract Documents.

Heavy-duty silt fence barriers shall be installed within a trench excavated along the contour of the ground such that the elevation of the bottom of the fence is the same along its entire length except at the ends. Heavy-duty silt fence barriers shall be installed without breaks or gaps along their entire length. Heavy-duty silt fence barriers shall only be installed on flat ground with a minimum offset of 2 m from the toe of the slope being protected. When a longer sediment barrier is required, another heavy-duty silt fence barrier shall be installed as specified in the Contract Documents.

The geotextile shall be attached firmly to the upstream side of the control measure support and the stakes. Stakes shall be spaced to ensure the geotextile and the control measure support remains vertical. Where the geotextile or the control measure support is joined to itself to provide a continuous run, the ends shall be overlapped a minimum of 500 mm and securely fastened to stakes using wire ties

at the top of the geotextile or the control measure support only. The geotextile and control measure support shall be angled upslope at the ends of each run in a “J” pattern and so that the ends are at a higher elevation than the bottom of the run.

When geotextile is supplied without the control measure support or stakes attached, the control measure support shall be installed into the trench in the ground first, the geotextile shall be installed into the trench on the upslope side of the control measures support, the stakes shall be driven into the ground behind the geotextile and the control measure support, and the geotextile and control measure support shall be attached to the stakes using wire ties at the top of the geotextile and control measure support and only.

805.07.03.02 Heavy-Duty Wire-Backed Silt Fence Barriers

Heavy-duty wire-backed silt fence barriers shall be constructed as specified in the Contract Documents.

Heavy-duty wire-backed silt fence barriers shall not be used for perimeter control or property line delineation unless specified in the Contract Documents.

Heavy-duty wire-backed silt fence barriers shall be installed in a trench excavated along the contour of the ground such that the elevation of the bottom of the fence is the same along its entire length except at the ends. Heavy-duty wire-backed silt fence shall be installed without breaks or gaps along their entire length. Heavy-duty wire-backed silt fence barriers shall only be installed on flat ground with a minimum offset of 2 m from the toe of the slope being protected. When a longer sediment barrier is required, another heavy-duty wire-backed silt fence barrier shall be installed as specified in the Contract Documents.

The wire control measure support shall be installed into the trench in the ground. The geotextile shall be installed into the trench on the upslope side of the wire control measure support. T-posts shall be installed into the ground behind the geotextile and wire control measure support and spaced to ensure the geotextile and wire control measure support remain vertical. The geotextile and the wire control measure support shall be attached securely to the T-posts using wire ties at the top of the geotextile and wire control measure support only. Where the geotextile or the wire control measure support is joined to itself to provide a continuous run, the ends shall be overlapped a minimum of 500 mm and securely fastened to T-posts using wire ties at the top of the geotextile or wire control measure support only. The geotextile wire control measure support shall be angled upslope at the ends of each run in a “J” pattern and so that the ends are at a higher elevation than the bottom of the run.

805.07.03.03 Berm Barriers

Berm barriers shall be constructed and wrapped in geotextile or plastic sheeting as specified in the Contract Documents. The geotextile or plastic sheeting shall be secured to the ground.

805.07.03.04 Sandbag Barriers

Sandbags shall be securely tied at the top.

Sandbag barriers shall be constructed as specified in the Contract Documents

Sandbags within each row shall be placed with the sides of the bags butted tightly against one another without gaps. The ends of sandbags in adjacent rows shall be butted tightly against one another without gaps.

When sandbag barriers are constructed on earth surfaces, the trench into which the sandbags are placed shall be backfilled around the sandbags to existing grade and compacted.

When sandbag barriers are to be constructed on sod, erosion control blanket, existing turf, or bedrock, they shall be placed so there are no gaps between the sandbags and the underlying surface.

Sandbag barriers shall be maintained with undamaged bags that are firmly seated.

805.07.04 Fibre Roll Grade Breaks

Fibre roll grade breaks shall be constructed as specified in the Contract Documents.

Fibre rolls shall be installed horizontally starting from the toe of the slope and working up to the top of the slope Any rills and gullies on the slope face shall be filled in as the fibre rolls are installed.

Fibre rolls shall be installed along the contour of the ground into trenches that have been excavated into the soil perpendicular to the slope face and width across the slope.

Fibre rolls shall be installed so that their base is in continuous contact with the underlying soil along their entire length without gaps and angled upslope at each end run in a "J" pattern. The ends of adjacent fibre roll segments shall be tightly butted up against each other and shall not be overlapped vertically or horizontally.

A metal bar shall be used to make pilot holes perpendicular to the slope face through the centre of the fibre rolls as specified in the Contract Documents. Pilot holes shall also be made at the ends of each fibre roll segment angled towards the next abutting fibre roll to hold adjacent rolls together.

Wooden stakes shall be driven into the pilot holes perpendicular to the slope face to secure the fibre rolls to the slope along their entire length. Additional stakes shall be driven into the fibre rolls along the downslope side at every grade change or if soils are very loose and uncompacted or the slope is steep.

Soil excavated from the trenches shall be placed along the upslope side of the fibre rolls and well compacted into the front of the trench to minimize possible undermining by runoff.

The soil on the upslope and downslope sides of the fibre rolls shall be seeded as specified in the Contract Documents.

805.07.05 Flow Check Dams - General

Flow check dams are straw bale flow check dams, fibre roll flow check dams, sandbag flow check dams, or rock flow check dams.

Flow check dams shall be constructed as specified in the Contract Documents such that the spillway level of the downstream flow check dam is the same as the base of the upstream flow check dam when they are specified in series. Flow check dams shall be constructed without gaps and without undermining to prevent sediment passage through, under, or around the flow check dam.

When the Flow Check Dams item is specified in the Contract Documents, any of the flow check dams or any combination of them may be used. When a specific flow check dam is specified in the Contract Documents, there shall be no option of substitution for the control measure.

Flow check dams shall include protection placed against the downstream side at the lowest point of the flow check dam so that any overflow of the flow check dam is prevented from causing soil scour and erosion.

805.07.05.01 Straw Bale Flow Check Dams

Straw bale flow check dams shall be constructed as specified in the Contract Documents and shall be replaced every 45 days.

805.07.05.02 Fibre Roll Flow Check Dams

Fibre roll flow check dams shall be constructed as specified in the Contract Documents.

805.07.05.03 Sandbag Flow Check Dams

Sandbag flow check dams shall be constructed as specified in the Contract Documents.

805.07.05.04 Rock Flow Check Dams

Rock flow check dams shall be constructed as specified in the Contract Documents.

805.07.06 Sediment Traps

Sediment traps shall be constructed as specified in the Contract Documents to prevent sediment passage from the upstream to the downstream side of the trap and so that the majority of the sediment is collected in the excavated basin.

Sediment traps shall be constructed as a single control measure consisting of an excavated basin and a rock flow check dam.

A temporary fence shall be erected around the sediment trap to restrict public access.

805.07.07 Slope Drains

Slope drains shall be constructed as specified in the Contract Documents.

Slope drains shall be constructed as a single control measure consisting of a corrugated pipe, two end sections including an inlet and an outlet, and a sediment trap constructed at the outlet end of the pipe.

The pipe inlet shall be placed through a berm barrier in such a manner that flow is directed to the pipe inlet without scouring of the berm. The toe plate of the inlet end section shall be fully imbedded into the ground surface.

Pipes shall be maintained in place without gaps and without undermining so that water is conveyed from the upstream side of the berm and collected in the sediment trap.

805.07.08 Diversion Ditches

Diversion ditches shall be constructed as specified in the Contract Documents.

When diversion ditches are specified to be lined with rolled erosion control blanket along their entire length it shall be according to OPSS 804.

Flow check dams shall be installed at regular intervals along the entire length of diversion ditches as specified in the Contract Documents.
Where diversion ditches are specified to be lined with rip-rap or granular it shall be according to OPSS 1004.

805.07.09 Sediment Traps for Dewatering

Sediment traps for dewatering shall be constructed as specified in the Contract Documents.

Sediment traps for dewatering shall be constructed a minimum of 30 m away from waterbodies or as far away as practicable from the top of the bank of any waterbody.

The shape of the excavated basin may be varied to suit the characteristics of the area surrounding it.

The sediment barrier and rock flow check dam shall be constructed as specified in the Contract Documents.

Construction of the sediment barrier shall be according to the requirements for light-duty sediment barriers with the following exceptions:

a) End runs are not required.

b) The rock flow check dam shall be located at the low point of the light-duty sediment barrier.

A temporary fence shall be erected around the sediment trap to restrict public access.

Discharge of water from sediment traps for dewatering shall be according to OPSS 517.

805.07.10 Filter Bags

Filter bags, hoses and pumps shall be sized appropriately to the volume as specified in the Contract Documents of water to be filtered. Bags shall have a FOS as specified in the Contract Documents.

Filter bags shall be situated in a vegetated area or placed on a permeable surface on a slight slope with the opening of the bag facing upslope a minimum of 30 m away from waterbodies or as far as practicable from the top of the bank of any waterbody.

The opening of the filter bag shall be securely attached with mechanical connections to the discharge hose using commercially available hose couplers and placed in the retention facility to be dewatered.

Discharge of water from filter bags shall be according to OPSS 517.

805.07.11 Turbidity Curtains

Turbidity curtains shall be constructed as specified in the Contract Documents. Turbidity curtains shall be free of tears and gaps, and the bottom edge of the curtain shall be continuously in contact with the waterbody bed so that sediment passage from the enclosed area is prevented.

Turbidity curtains shall be constructed according to the following:

a) Breaks may be made in the lower sleeve to facilitate pulling of the ballast, provided they are a maximum 100 mm in size and spaced at minimum 3 m intervals.

b) Where turbidity curtain geosynthetic is joined to provide a continuous run, the sections shall be connected to provide a continuous seal to prevent the escape of turbid water between the sections.

c) The turbidity curtain shall be of sufficient width to account for water depth and wave action.

d) The turbidity curtain shall be prepared for installation by furling and tying securely with furling ties every 1.5 m for the entire length of the curtain.

e) Anchor locations shall be established as necessary to maintain the turbidity curtain in place and functioning.

The sequence of installation shall be according to the following:

a) Tie-downs shall firmly anchor the turbidity curtain to the shoreline.

b) One end of the furled curtain shall be firmly attached to the upstream tie-down.

c) The furled curtain shall be launched and placed.

d) The other end of the furled curtain shall be attached to the downstream tie-down.

e) Each anchor shall be attached to the turbidity curtain load line with a mooring line.

f) Mooring buoys shall be attached to the mooring line at a distance of 1 m from the load line to keep the turbidity curtain in place at locations where it changes direction.

g) The furling ties shall be released to allow the turbidity curtain ballast to sink to its maximum depth.

h) The location and depth of the ballast shall be adjusted as necessary using the adjustment lines.

Equipment is permitted in the working area enclosed by the turbidity curtain.

Folds in the turbidity curtain that form next to the floatation collar shall be regularly monitored and cleared of collected sediment.

805.07.12 Cofferdams

Cofferdams shall be constructed as specified in the Contract Documents to:

a) Isolate the working area from the waterbody.

b) Prevent the release of sediment and debris into the surrounding waterbody.

Equipment is permitted in the working area enclosed by the cofferdam.

805.07.13 Monitoring

All temporary erosion and sediment control measures shall be monitored to ensure they are in effective working order. Monitoring shall be once a week, at minimum, prior to any forecast rain event and following any rain event.

805.07.14 Maintenance

All temporary erosion and sediment control measures constructed under this specification shall be maintained in an effective, functioning, stable condition.

805.07.15 Sediment Removal

The work shall consist of the removal and management of accumulated sediment.

Sediment that is accumulated by the temporary erosion and sediment control measures shall be removed in a manner that avoids escape of the sediment to the downstream side of the control measure and avoids damage to the control measure. Sediment shall be removed to the level of the grade existing at the time the control measure was constructed and be according to the following:

a) For light-duty sediment barriers and flow check dams, accumulated sediment shall be removed once it reaches the lesser of the following:

    i. A depth of one-half the effective height of the control measure. For flow check dams, the effective height shall be determined relative to the lowest point of the flow check dam.
    ii. A depth of 300 mm immediately upstream of the control measure.

b) For heavy-duty sediment barriers, sediment traps, and sediment traps for dewatering, accumulated sediment shall be removed once it reaches one-half the effective height or depth of the control measure.

c) For all control measures, accumulated sediment shall be removed as necessary to perform maintenance repairs.

d) Accumulated sediment shall be removed immediately prior to the removal of the control measure.

805.07.16 Control Measure Removal

Ditch, permanent slope, and any other embankment cover specified elsewhere in the Contract Documents to be placed within the area controlled by the temporary erosion and sediment control measure shall be in place and established prior to the removal of such control measure.

Temporary erosion and sediment control measures shall be removed and associated excavations backfilled and compacted when the measures are no longer required.

Temporary erosion and sediment control measures shall be removed in a manner that:

a) Prevents entry of equipment, other than hand-held equipment or boats, to any waterbody.

b) Prevents release of sediment and debris to any waterbody.

Prior to removal of the in-water control measures, the area enclosed by turbidity curtains and cofferdams shall be cleaned of all debris. For cofferdams, accumulated sediment shall be removed prior to removal of the sediment control measure.

Any seeding and mulching, temporary cover, sod, other surface application, or original turf cover disturbed by removal or backfilling of erosion and sediment control measures and removal of accumulated sediment, shall be brought to final grade and restored as specified in the Contract Documents.

805.07.17 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

805.07.18 Protection of Waterbodies and Waterbody Banks

Protection of waterbodies and waterbody banks shall be as specified in the Contract Documents.

805.09 MEASUREMENT FOR PAYMENT

805.09.01 Actual Measurement

805.09.01.01 Light-Duty Sediment Barriers
Light-Duty Straw Bale Barriers
Light-Duty Silt Fence Barriers
Light-Duty Fibre Roll Barriers
Heavy-Duty Sediment Barriers
Heavy-Duty Silt Fence Barriers
Heavy-Duty Wire-Backed Silt Fence Barriers
Berm Barriers
Sandbag Barriers
Fibre Roll Grade Breaks

Measurement shall be the length in lineal metres from end to end of the barrier constructed, maintained, and removed, following the contours of the ground.

805.09.01.02 Flow Check Dams
Straw Bale Flow Check Dams
Fibre Roll Flow Check Dams
Sandbag Flow Check Dams
Rock Flow Check Dams

For measurement purposes, a count shall be made of the flow check dams constructed, maintained, and removed.

805.09.01.03 Sediment Traps
Slope Drains
Diversion Ditches
Sediment Traps for Dewatering
Filter Bags

For measurement purposes, a count shall be made of the number of sediment traps, slope drains, diversion ditches, sediment traps for dewatering and filter bags constructed or installed, maintained, and removed. Component parts shall not be counted separately for payment.

805.09.01.04 Turbidity Curtains

Measurement of turbidity curtain shall be made in lineal metres along its length from end to end between tie-downs for each turbidity curtain installed, maintained, and removed.

805.09.01.05 Cofferdams

For measurement purposes, a count shall be made of the number of cofferdams constructed, maintained, and removed.

805.09.01.06 Sediment Removal

Measurement shall be as specified in the Contract Documents by the volume of sediment excavated in cubic meters or by the number of hours required for excavation of sediment.

805.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

805.10 BASIS OF PAYMENT

805.10.01 Light-Duty Sediment Barriers - Item
Light-Duty Straw Bale Barriers - Item
Light-Duty Silt Fence Barriers – Item
Light-Duty Fibre Roll Barriers - Item
Heavy-Duty Sediment Barriers - Item
Heavy-Duty Silt Fence Barriers – Item
Heavy-Duty Wire-Backed Silt Fence Barriers – Item
Berm Barriers - Item
Sandbag Barriers - Item
Fibre Roll Grade Breaks – Item
Flow Check Dams - Item
Straw Bale Flow Check Dams - Item
Fibre Roll Flow Check Dams - Item
Sandbag Flow Check Dams - Item
Rock Flow Check Dams – Item
Sediment Traps - Item
Slope Drains – Item
Diversion Ditches - Item
Sediment Traps for Dewatering – Item
Filter Bags - Item
Turbidity Curtains - Item
Cofferdams - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material required to do the work.

Progress payments for the temporary erosion and sediment control measures shall be made as follows:

a) 30% for initial construction.

b) 50% for maintenance.

c) 20% for removal.

805.10.02 Sediment Removal - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

When the Contract Documents do not have a separate item for sediment removal, payment at the Contract price for the appropriate tender item for the installation of the sediment control measures shall be full compensation for all labour, Material, and Equipment to do the work of sediment removal.

Appendix 805-A, November 2021
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Installation and removal times for temporary erosion and sediment control measures. (805.07.01.06)

- Grading requirements for control measure removal. (805.07.16)

- Sediment removal measurement for payment. (805.09.01.06)

The designer should determine the need for barrier installation. The desirable slope grade is maximum 5%. (805.07.02 and 805.07.03)

The designer should determine the following and, if they are required, the requirements should be included in the Contract Documents:

- Sensitive environmental features. (805.07.01.03)

- The need for a specific light-duty sediment barrier. Where the light-duty sediment barrier is to be built using fibre rolls, the diameter of the fibre rolls to be used and whether and how they may be stacked vertically. (805.07.02)

- The type of seed mix to be applied to the upslope and downslope sides of fibre roll grade breaks. (805.07.02.03)

- The need for a specific heavy-duty sediment barrier. Where the heavy-duty sediment barrier is to be built using fibre rolls, the diameter of the fibre rolls to be used and whether and how they may be stacked vertically. (805.07.03)

- The need for wire backing for a heavy-duty silt fence barrier. (805.07.03.02)

- The need for fibre roll grade breaks and the number, diameter and spacing of fibre rolls required. (805.07.04)

- The need for a specific flow check dam, the number of flow check dams in series required and the spacing of the flow check dams. (805.07.05)

- The need for a sediment trap(s). When a sediment trap is to be constructed in a ditch the outside edge shall be sized to extend beyond the base of the ditch. (805.07.06)

- The need for a slope drain(s). (805.07.07)

Identify the need for a diversion ditch(s). Design dimensions and direction of flow along contour of ground. Outlet details including scour protection and sediment control. The need for, type and number of flow check dam(s), and type of erosion control lining. (805.07.08)

- The need for a sediment trap(s) for dewatering. Ensure that sediment traps for dewatering are sized appropriately for the catchment area and that there is enough space available to construct them. (805.07.09)

- The need for filter bags, and the type, Class and filtration opening size (FOS) of geotextile to be used. (805.07.10)

- Appropriate volume of water to be filtered. (805.07.10)

- The need for a turbidity curtain(s). (805.07.11)

- The need for and design of a cofferdam(s). (805.07.12)

- Whether sediment removal is to be measured by volume or time. (805.09.01.06)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 219.100	Light-Duty Straw Bale Barrier
OPSD 219.110	Light-Duty Silt Fence Barrier
OPSD 219.120	Light-Duty Fibre Roll Barrier
OPSD 219.130	Heavy-Duty Silt Fence Barrier
OPSD 219.131	Heavy-Duty Wire-Backed Silt Fence Barrier
OPSD 219.150	Sandbag Barrier
OPSD 219.160	Fibre Roll Grade Breaks
OPSD 219.180	Straw Bale Flow Check Dam
OPSD 219.191	Fibre Roll Flow Check Dam
OPSD 219.200	Sandbag Flow Check Dam
OPSD 219.210	Temporary Rock Flow Check Dam V-Ditch
OPSD 219.211	Temporary Rock Flow Check Dam Flat Bottom Ditch
OPSD 219.220	Sediment Trap In Ditch
OPSD 219.230	Temporary Slope Drain For Sediment Trap
OPSD 219.231	Temporary Berm Barrier
OPSD 219.240	Sediment Trap for Dewatering
OPSD 219.260	Turbidity Curtain
OPSD 219.261	Turbidity Curtain Seam Detail

CONSTRUCTION SPECIFICATION FOR ROOTWAD STRUCTURES

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810.08 **QUALITY ASSURANCE - Not Used**

810.09 **MEASUREMENT FOR PAYMENT**

810.10 **BASIS OF PAYMENT**

APPENDICES

810-A **Commentary**

810.01 SCOPE

This specification covers the requirements for the installation of rootwad structures to provide waterbody bank stabilization and to improve fish habitat.

810.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

This specification applies to the work associated with installing rootwad structures without limiting the conditions and approvals imposed by statute.

810.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

810.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 206 Grading
OPSS 517 Dewatering

Ontario Provincial Standard Specifications, Material

OPSS 1440 Steel Reinforcement for Concrete

810.03 DEFINITIONS

For the purpose of this specification, the definitions in OPSS 182 and the following definitions apply:

Anchoring Stone means large stones used to anchor rootwad structures into a waterbody bank.

Excavated Bank Material means the existing earth material removed from the waterbody bank prior to the installation of a rootwad structure and replaced on top of the anchoring stone when backfilling the installation.

Footer Log means a log used to provide support under the rootwad trunk of a rootwad structure installed into a waterbody bank.

Low Water Level means the lowest point on the bank or streambed of a waterbody that the water level recedes to during low flow events or periods.

Rootfan means the root mass at the end of a rootwad trunk.

Rootwad Structure means the trunk of a tree with the limbs removed and the rootfan attached and exposed from earth that is installed along the toe of a waterbody bank to stabilize the slope and provide fish habitat, and includes a footer log, anchoring stone, and may include reinforcing steel.

Rootwad Trunk means the trunk of a tree used in a rootwad structure.

810.05 MATERIALS

810.05.01 General

All materials shall be free of deleterious substances.

810.05.02 Trees

Trees used for rootwad structures and footer logs shall be natural and untreated oak, maple, cedar, spruce, pine, or beech.

Preference shall be given to trees sourced on-site.

810.05.03 Rootwad Trunk

The rootwad trunk shall be sized as specified in the Contract Documents. All limbs shall be removed from the rootwad trunk.

810.05.04 Rootfan

The rootfan shall be maintained intact at the end of the rootwad trunk.

810.05.05 Footer Log

Footer logs shall be generally straight and sized as specified in the Contract Documents.

810.05.06 Anchoring Stone

Anchoring stone shall be large field stone or quarried bedrock.

810.05.07 Reinforcing Steel

Reinforcing steel shall be according to OPSS 1440.

810.07 CONSTRUCTION

810.07.01 General

Rootwad structures shall be installed in the dry. The outside edge of the rootfan of a rootwad structure shall be installed so that it is no lower than the bottom of the waterbody or otherwise so that it is 1/3 below the low water level of the waterbody as specified in the Contract Documents.

810.07.02 Installation

Installation of rootwad structures shall be completed in the following sequence:

a) The waterbody bank shall be excavated to accommodate the entire length of the rootwad trunk and the footer log. The excavation shall be slightly angled to become deeper further inland from the edge of the waterbody.

b) The excavated bank materials shall be reused for the final layer when backfilling.

c) The footer log shall be installed so that it sits at the waterbody edge of the excavation, parallel to the waterbody bank, and at the depth as specified in the Contract Documents. When more than one rootwad structure is to be installed in series, the footer logs shall be installed starting at the downstream end of the installation.

d) The rootwad trunk shall be placed in the excavation resting on the footer log so that it is embedded into the waterbody bank up to the rootfan. The rootwad trunk shall be angled slightly in the excavation so that the rootwad structure is facing upstream at an angle, as specified in the Contract Documents, to the waterbody bank and shall be anchored into the bank with reinforcing steel when specified in the Contract Documents.

e) Anchoring stone shall be installed on the rootwad trunk and footer log to secure the rootwad structure in place. The anchoring stone shall cover minimum 1.5 times the diameter of the rootwad trunk, both in horizontal and vertical directions, or sized as specified in the Contract Documents. The rootwad trunk and the footer log shall not be visible from above.

f) The previously excavated bank material shall be placed over the anchoring stone and graded according to OPSS 206.

g) Vegetative cover shall be applied to the graded area as specified in the Contract Documents.

810.07.03 Protection of Waterbodies and Waterbody Banks

Protection of waterbodies and waterbody banks shall be as specified in the Contract Documents.

810.07.04 Dewatering and Temporary Flow Control

Dewatering and/or temporary flow control shall be according to OPSS 517.

810.07.05 Management of Excess Materials

Management of excess materials shall be as specified in the Contract Documents.

810.09 MEASUREMENT FOR PAYMENT

810.09.01 Actual Measurement

810.09.01.01 Rootwad Structure

For measurement purposes, a count shall be made of the number of rootwad structures installed along the waterbody bank.

810.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

810.10 BASIS OF PAYMENT

810.10.01 Rootwad Structure - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

Appendix 810-A, April 2022
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The following should be specified in the Contract Documents:

- Trees used for rootwad structures and footer logs other than natural and untreated oak, maple, cedar, spruce, pine, or beech and when other than on-site materials may be used. (810.05.02)

- Size of the rootwad trunk if other than typical size. (810.05.03)

- Size of footer log if other than typical size. (810.05.05)

- Requirement of reinforcing steel for anchoring into the bank, when required. (810.07.02)

- Size of the anchoring stone, when required. (810.07.02)

- Application of vegetative cover to the graded area. (810.07.02)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 222.010	Rootwad Structures

CONSTRUCTION SPECIFICATION FOR LARGE WOODY DEBRIS

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811.04 **DESIGN AND SUBMISSION REQUIREMENTS - Not Used**

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811.06 **EQUIPMENT - Not Used**

811.07 **CONSTRUCTION**

811.08 **QUALITY ASSURANCE - Not Used**

811.09 **MEASUREMENT FOR PAYMENT**

811.10 **BASIS OF PAYMENT**

APPENDICES

811-A **Commentary**

811.01 SCOPE

This specification covers the requirements for the installation of large woody debris to provide waterbody bank stabilization and improve fish habitat.

811.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be as specified in Contract Documents.

811.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

811.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 206 Grading
OPSS 517 Dewatering

Ontario Provincial Standard Specifications, Material

OPSS 1004 Aggregates - Miscellaneous

811.03 DEFINITIONS

For the purpose of this specification, the definitions in OPSS 182 and the following definitions apply:

Backfill Stone means a stone mixture used to hold in place large woody debris.

Excavated Bank Material means the existing earth material removed from the waterbody bank prior to the installation of large woody debris and replaced when backfilling the installation.

Large Woody Debris means one or more woody materials including, natural logs, tree trunks and limbs, or tree stumps with rootfans intertwined together and applied along the toe of a waterbody bank when the toe of the waterbody bank is being eroded and includes backfill stone.

Rootfan means the root mass at the end of the trunk of a tree.

811.05 MATERIALS

811.05.01 Large Woody Debris

Large woody debris materials shall be sized as specified in the Contract Documents.

Preference shall be given to wood debris and dead trees sourced on-site.

811.05.02 Backfill Stone

Backfill stone shall be pit run material according to OPSS 1004 and as specified in the Contract Documents. Alternatively, excavated bank material may be used in conjunction with backfill stone.

811.07 CONSTRUCTION

811.07.01 General

Large woody debris shall be installed in the dry.

Adjacent to, but not within the installation area, the large woody debris shall be intertwined to create a mass, sized as specified in the Contract Documents.

811.07.02 Installation

Installation of large woody debris shall be completed in the following sequence:

a) The installation area shall be excavated as specified in the Contract Documents. Excavated bank material may be reused for the final layer when backfilling or mixed with the backfill stone if suitable.

b) The large woody debris mass shall be placed in the excavation, ensuring that the large woody debris is situated in an irregular fashion as specified in the Contract Documents. The large woody debris mass shall extend to the back of the excavation and also extend into the waterbody as specified in the Contact Documents.

c) The large woody debris shall be covered with backfill stone as specified in the Contract Documents and tamped down. The backfill stone shall be covered with a layer of the excavated bank material and graded according to OPSS 206.

d) Vegetative cover shall be applied to the graded area as specified in the Contract Documents.

811.07.03 Protection of Waterbodies and Waterbody Banks

Protection of waterbodies and waterbody banks shall be as specified in the Contract Documents.

811.07.04 Dewatering and Temporary Flow Control

Dewatering and/or temporary flow control shall be according to OPSS 517.

811.07.05 Management of Excess Materials

Management of excess materials shall be as specified in the Contract Documents.

811.09 MEASUREMENT FOR PAYMENT

811.09.01 Actual Measurement

811.09.01.01 Large Woody Debris

Measurement of large woody debris shall be in linear metres, in place, as measured along the top of the waterbody bank.

811.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

811.10 BASIS OF PAYMENT

811.10.01 Large Woody Debris - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

Appendix 811-A, November 2022
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The following should be specified in the Contract Documents:

- Size of large woody debris materials. (811.05.01)

- Backfill stone material. (811.05.02)

- Length and diameter of large woody debris mass. (811.07.01)

- Excavation of installation area. (811.07.02)

- Application of vegetative cover to the graded area. (811.07.02)

- Protection of waterbodies and waterbody banks. (811.07.03)

- Management of excess materials. (811.07.05)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 222.020	Large Woody Debris for Waterbody Banks

CONSTRUCTION SPECIFICATION FOR LUNKERS

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812.08 **QUALITY ASSURANCE - Not Used**

812.09 **MEASUREMENT FOR PAYMENT**

812.10 **BASIS OF PAYMENT**

APPENDICES

812-A **Commentary**

812.01 SCOPE

This specification covers the requirements for the construction of LUNKERS for the stability of waterbody banks and fish habitat enhancement.

812.01.01 Specification Significance and Use

This specification has been developed for use in municipal oriented Contracts. The administration, testing, and payment policies, procedures, and practices reflected in this specification correspond to those used by many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

812.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

812.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 206 Grading
OPSS 517 Dewatering

Ontario Provincial Standard Specifications, Materials

OPSS 1005 Aggregates - Waterbody
OPSS 1010 Aggregates - Base, Subbase, Select Subgrade, and Backfill Material
OPSS 1440 Steel Reinforcement for Concrete

812.03 DEFINITIONS

For the purpose of this specification, the definitions in OPSS 182 and the following definitions apply:

Cover Stone means one or more large stones used to create the top of stone LUNKERS.

Excavated Bank Material means the existing earth material removed from the waterbody bank prior to the installation of LUNKERS and replaced when backfilling the installation.

LUNKERS means an acronym for Little Underwater Neighbourhood Keepers Encompassing Rheotactic Salmonids that are crib-like, wooden, or stone structures installed along the toe of a waterbody bank.

Spacer Stone means a stone installed under the cover stone of stone LUNKERS and on top of the waterbody aggregate to create space under the cover stone.

812.05 MATERIALS

812.05.01 General

All materials shall be free of deleterious substances.

812.05.02 Wood

Wood LUNKERS shall be constructed of local wood, untreated lumber or rough-hewn logs.

Planks, stringers, backboards, and posts for wood LUNKERS shall be as specified in the Contract Documents.

Planks shall be placed side-by-side, without any gaps.

812.05.03 Waterbody Aggregates

Waterbody aggregates shall be according to OPSS 1005 and as specified in the Contract Documents.

812.05.04 Granular B Aggregate

Granular B aggregate shall be according to OPSS 1010, except that it may not contain reclaimed asphalt pavement, reclaimed concrete material, glass, ceramic, fly ash, any type of slag, or any other industrial by-product, and shall be made from unwashed, quarried bedrock.

812.05.05 Spacer and Cover Stones

Spacer and cover stones shall be as specified in the Contract Documents.

812.05.06 Reinforcing Steel

Reinforcing steel shall be according to OPSS 1440.

812.07 CONSTRUCTION

812.07.01 General

LUNKERS shall be installed in the dry.

812.07.02 Installation

812.07.02.01 Wood LUNKERS

Wood LUNKERS shall be constructed on land outside the waterbody as specified in the Contract Documents, prior to installation in the waterbody bank.

Installation of wood LUNKERS shall be completed in the following sequence:

a) The waterbody bed and bank shall be excavated to accommodate wood LUNKERS as specified in the Contract Documents.

b) Wood LUNKERS shall be installed in the excavation as specified in the Contract Documents.

c) Adjustments to level and stabilize wood LUNKERS shall be made by hand.

d) Holes shall be drilled through the posts of wood LUNKERS to accommodate the reinforcing steel and the reinforcing steel shall be driven through wood LUNKERS and into the waterbody bed.

e) Waterbody aggregates shall be placed on wood LUNKERS and extend to the high water level of the waterbody to re-establish the waterbody bank as specified in the Contract Documents. Granular B aggregate shall be installed at the rear of the excavation as specified in the Contract Documents.

Excavated bank material shall be installed on top of the waterbody aggregates and Granular B aggregate as specified in the Contract Documents and graded according to OPSS 206. Vegetative cover shall be applied to the graded area as specified in the Contract Documents.

812.07.02.02 Stone LUNKERS

Installation of stone LUNKERS shall be completed in the following sequence:

a) The waterbody bank and bed shall be excavated to accommodate stone LUNKERS as specified in the Contract Documents. Excavated bank material shall be reused for the final layer when backfilling.

b) Waterbody Aggregates shall be placed on the waterbody bed to create a flat, stable base for stone LUNKERS as specified in the Contract Documents.

c) Spacer stones shall be installed on the waterbody aggregates as specified in the Contract Documents. Spacer stones shall be installed to be at the mid-point and at each end of the length of the cover stone. The cover stone shall then be lowered onto the spacer stones. Adjustments shall be made to level and stabilize stone LUNKERS.

d) Waterbody Aggregates shall be placed on the cover stone of stone LUNKERS to re-establish the waterbody bank as specified Contract Documents. Granular B aggregate shall be installed on top of the waterbody aggregates as specified in the Contract Documents.

e) The excavated bank material shall be placed over the Granular B aggregate as specified in the Contract Documents and graded according to OPSS 206.

f) Vegetative cover shall be applied to the graded area as specified in the Contract Documents.

812.07.03 Protection of Waterbodies and Waterbody Banks

Protection of waterbodies and waterbody banks shall be as specified in the Contract Documents.

812.07.04 Dewatering and Temporary Flow Control

Dewatering and/or temporary flow control shall be according to OPSS 517.

812.07.05 Management of Excess Materials

Management of excess materials shall be as specified in the Contract Documents.

812.09 MEASUREMENT FOR PAYMENT

812.09.01 Actual Measurement

812.09.01.01 Wood LUNKERS
Stone LUNKERS

Measurement of wood and stone LUNKERS shall be in linear metres, in place, as measured along the top of the waterbody bank.

812.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

812.10 BASIS OF PAYMENT

812.10.01 Wood LUNKERS - Item
Stone LUNKERS - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Appendix 812-A, November 2022
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The following should be specified in the Contract Documents:

- Planks, stringers, backboards, and posts for wood LUNKERS. (812.05.02)

- Waterbody aggregate material. (812.05.03)

- Spacer and cover stone material. (812.05.05)

- Wood LUNKER construction prior to installation. (812.07.02.01)

- Waterbody bed and bank excavation to accommodate wood LUNKERS. (812.07.02.01)

- Wood LUNKER installation in excavated area (812.07.02.01)

- Re-establishment of the waterbody bank for wood LUNKERS. (812.07.02.01)

- Installation of Granular B aggregate for wood LUNKERS. (812.07.02.01)

- Installation of excavated bank material for wood LUNKERS. (812.07.02.01)

- Application of vegetative cover to the graded area for wood LUNKERS. (812.07.02.01)

- Waterbody bed and bank excavation to accommodate stone LUNKERS. (812.07.02.02)

- Waterbody aggregate placement on waterbody bed for stone LUNKER base. (812.07.02.02)

- Spacer stone installation on waterbody aggregates for stone LUNKERS. (812.07.02.02)

- Re-establishment of the waterbody bank and Granular B installation for stone LUNKERS. (812.07.02.02)

- Placement of excavated bank material over Granular B aggregate for stone LUNKERS. (812.07.02.02)

- Application of vegetative cover to the graded area for stone LUNKERS. (812.07.02.02)

- Protection of waterbodies and waterbody banks. (812.07.03)

- Management of excess materials. (812.07.05)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 222.030	Stone LUNKERS
OPSD 222.040	Wood LUNKERS

ONTARIO PROVINCIAL STANDARD SPECIFICATION

METRIC
OPSS 820
APRIL 2017
(Formerly OPSS 820, November 2014)

Note: The MUNI implemented in April 2017 replaces OPSS 820 COMMON, November 2014 with no technical content changes.

CONSTRUCTION SPECIFICATION FOR RIFFLES ON STREAMBEDS

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820.08 **QUALITY ASSURANCE - Not Used**

820.09 **MEASUREMENT FOR PAYMENT**

820.10 **BASIS OF PAYMENT**

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820-A **Commentary**

820.01 SCOPE

This specification covers the requirements for the construction of riffles on streambeds.

820.01.01 Specification Significance and Use

This specification has been developed for use in municipal oriented Contracts. The administration, testing, and payment policies, procedures, and practices reflected in this specification correspond to those used by many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

820.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

820.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 823 Low Flow Channels

Ontario Provincial Standard Specifications, Material

OPSS 1005 Aggregates - Streambed Material

Canadian and Provincial Statutes

Fisheries Act, R.S.C., 1985, c. F-14, as amended
Ontario Water Resources Act, R.S.O. 1990, c. 0.40, as amended

820.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Anchor Stones means of large stones (i.e., boulders) used to create a stable base.

Deleterious Substance means as defined in the Fisheries Act.

High Water Level means the highest point on the bank or floodplain of a waterbody where the water level reaches during high flow events or periods.

Interstitial Space means an empty space or gap between spaces full of structure or matter.

Low Flow Channel means the part of a streambed occupied by water during periods of low flow that is critical for fish passage.

Low Water Level means the lowest point on the bank or streambed of a waterbody where the water level recedes to during low flow events or periods.

Normal Water Level means the average water level that occurs between high water level events or periods and low water level events or periods.

Riffles means shallow areas of a waterbody with the steepest streambed slopes and shallowest depths where rocks break up the flow of water.

Riffle Crest means the highest point of a riffle at its upstream end.

Streambed means the bottom of the channel where a watercourse flows.

Streambed Material means the material that rests on the bottom of a waterbody and typically consists of natural sand, gravel, cobble, and boulders.

Waterbody means any permanent or intermittent, natural or constructed body of water, including lakes, ponds, wetlands, and watercourses, but does not include sewage works as defined in the Ontario Water Resources Act.

Waterbody Bank means the slope on or adjacent to a waterbody from the normal water level to the top of slope.

Watercourse means a stream, creek, river, or channel including ditches, in which the flow of water is permanent, intermittent, or temporary.

820.05 MATERIALS

820.05.01 Streambed Material

Streambed material shall be according to OPSS 1005 and as specified in the Contract Documents.

820.07 CONSTRUCTION

820.07.01 General

Riffles shall be constructed in the dry.

820.07.02 Channel Excavation

All required channel excavation shall be carried out as specified in the Contract Documents.

820.07.03 Streambed Material

The streambed material shall be blended on site and as specified in the Contract Documents. Approximately 10 - 20% of the largest size of streambed material to be used shall be set aside and positioned on top of the smaller streambed material to direct the stream flow.

Streambed material placement shall commence at the downstream end of the waterbody as specified in the Contract Documents and progress to the upstream end. Streambed material shall be compacted and interstitial spaces shall be filled as specified in the Contract Documents.

The riffle crest shall be constructed across the stream with large diameter boulders backed up with the next largest stone size downstream. Anchor stones shall be placed on the streambed as specified in the Contract Documents to create the upstream slope of the riffle and shall extend to the high water level of the waterbody. The thickness of each riffle crest shall be two to three times the diameter of the largest streambed material size.

The surface of the downstream face of the riffle shall have large streambed material placed so that they are spaced 20 - 30 cm apart to form gaps as specified in the Contract Documents.

Both waterbody banks adjacent to the riffle site shall have streambed material placed up to the high water level of the waterbody as specified in the Contract Documents.

Once placed, the streambed material shall form a non-uniform surface with larger stones protruding above smaller stones.

820.07.04 Low Flow Channel

A low flow channel shall be installed within the riffle according to OPSS 823 so that it has a 'V' shape in cross section at the center of the riffle.

820.07.05 Protection of Waterbodies and Waterbody Banks

Protection of waterbodies and waterbody banks shall be according to the Contract Documents.

820.07.06 Temporary Flow Control for Construction in Waterbodies

Temporary flow control for construction in waterbodies shall be according to the Contract Documents.

820.07.07 Management of Excess Materials

Management of excess materials shall be according to the Contract Documents.

820.09 MEASUREMENT FOR PAYMENT

820.09.01 Actual Measurement

820.09.01.01 Riffles

Measurement for riffles shall be by horizontal area in square metres.

820.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

820.10 BASIS OF PAYMENT

820.10.01 Riffles - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

Appendix 820-A, November 2014
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Streambed material. (820.05.01)

- Channel excavation. (820.07.02)

- The locations and dimensions of the riffles on the streambeds at the Contract site including locations where streambed material should extend up the waterbody banks to the high water level of the waterbody. (820.07.03)

- The gradation of the various components of streambed material including anchor stones according to OPSS 1005 required to construct the riffles that are suitable to the Contract site. (820.07.03)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 222.050 Riffles on Streambeds

ONTARIO PROVINCIAL STANDARD SPECIFICATION

METRIC
OPSS 821
APRIL 2017
(Formerly OPSS 821, November 2014)

Note: The MUNI implemented in April 2017 replaces OPSS 821 COMMON, November 2014 with no technical content changes.

CONSTRUCTION SPECIFICATION FOR POOLS IN STREAMBEDS

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821.07 **CONSTRUCTION**

821.08 **QUALITY ASSURANCE - Not Used**

821.09 **MEASUREMENT FOR PAYMENT**

821.10 **BASIS OF PAYMENT**

APPENDICES

821-A **Commentary**

821.01 SCOPE

This specification covers the requirements for the construction of pools in streambeds.

821.01.01 Specification Significance and Use

This specification has been developed for use in municipal oriented Contracts. The administration, testing, and payment policies, procedures, and practices reflected in this specification correspond to those used by many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

821.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

821.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Material

OPSS 1005 Aggregates - Streambed Material

Canadian and Provincial Statutes

Fisheries Act, R.S.C., 1985, c. F-14
Ontario Water Resources Act, R.S.O. 1990, c. 0.40

821.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Deleterious Substance means as defined in the Fisheries Act.

Pools means hydrologic segments of a waterbody where the water is deeper and slower.

Streambed means the bottom of the channel where a watercourse flows.

Streambed Material means the material that rests on the bed of a waterbody and typically consists of natural sand, gravel, cobble, and boulders.

Waterbody means any permanent or intermittent, natural or constructed body of water, including lakes, ponds, wetlands, and watercourses, but does not include sewage works as defined in the Ontario Water Resources Act.

Watercourse means a stream, creek, river, or channel including ditches, in which the flow of water is permanent, intermittent, or temporary.

821.05 MATERIALS

821.05.01 Streambed Material

Streambed material shall be according to OPSS 1005 and as specified in the Contract Documents.

821.07 CONSTRUCTION

821.07.01 General

Pools shall be excavated in the dry.

821.07.02 Pools

Pools shall be excavated in the streambed as specified in the Contract Documents.

Any materials to be reused that must be temporarily removed from the streambed shall be stored on-site as specified in the Contract Documents.

821.07.03 Streambed Material

Streambed material shall be installed on the streambed within the pools as specified in the Contract Documents.

821.07.04 Protection of Waterbodies and Waterbody Banks

Protection of waterbodies and waterbody banks shall be according to the Contract Documents.

821.07.05 Temporary Flow Control for Construction in Waterbodies

Temporary flow control for construction in waterbodies shall be according to the Contract Documents.

821.07.06 Management of Excess Materials

Management of excess materials shall be according to the Contract Documents.

821.09 MEASUREMENT FOR PAYMENT

821.09.01 Actual Measurement

821.09.01.01 Pools

Measurement for pools shall be by horizontal area in square metres.

821.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

821.10 BASIS OF PAYMENT

821.10.01 Pools - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

Appendix 821-A, November 2014
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Streambed material. (821.05.01)

- Pool excavation. (821.07.02)

- The gradation of the various components of streambed material according to OPSS 1005 required to be installed within the pools that are suitable to the Contract site. (821.07.03)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 222.060 Pools in Streambeds

ONTARIO PROVINCIAL STANDARD SPECIFICATION

METRIC
OPSS 822
APRIL 2017
(Formerly OPSS 822, November 2014)

Note: The MUNI implemented in April 2017 replaces OPSS 822 COMMON, November 2014 with no technical content changes.

CONSTRUCTION SPECIFICATION FOR ROCKY RAMPS ON STREAMBEDS

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822.08 **QUALITY ASSURANCE - Not Used**

822.09 **MEASUREMENT FOR PAYMENT**

822.10 **BASIS OF PAYMENT**

APPENDICES

822-A **Commentary**

822.01 SCOPE

This specification covers the requirements for the construction of rocky ramps on streambeds.

822.01.01 Specification Significance and Use

This specification has been developed for use in municipal oriented Contracts. The administration, testing, and payment policies, procedures, and practices reflected in this specification correspond to those used by many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

822.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

822.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Material

OPSS 1005 Aggregates - Streambed Material

Canadian and Provincial Statutes

Fisheries Act, R.S.C., 1985, c. F-14, as amended
Ontario Water Resources Act, R.S.O. 1990, c. 0.40, as amended

822.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Anchor Stones means streambed material consisting of large stones (i.e., boulders) used to create a stable base.

Boulder Weir means a grade control structure to slow water behind it.

Boulder Weir Crest means the top of the boulder weir.

Deleterious Substance means as defined in the Fisheries Act.

High Water Level means the highest point on the bank or floodplain of a waterbody where the water level reaches during high flow events or periods.

In-stream Obstruction means a barrier in a waterbody that prohibits fish passage.

Low Flow Channel means the part of a streambed occupied by water during periods of low flow that is critical for fish passage.

Low Water Level means the lowest point on the bank or streambed of a waterbody where the water level recedes to during low flow events or periods.

Normal Water Level means the average water level that occurs between high water level events or periods and low water level events or periods.

Pool means a hydrologic segment of a waterbody where the water is deeper and slower.

Rocky Ramp means a longitudinal series of boulder weirs and pools creating a low slope that simulates a rocky streambed.

Streambed means the bottom of the channel where a watercourse flows.

Streambed Material means the material that rests on the bottom of a waterbody and typically consists of natural sand, gravel, cobble, and boulders.

Waterbody means any permanent or intermittent, natural or constructed body of water, including lakes, ponds, wetlands, and watercourses, but does not include sewage works as defined in the Ontario Water Resources Act.

Waterbody Bank means the slope on or adjacent to a waterbody from the normal water level to the top of slope.

Watercourse means a stream, creek, river, or channel including ditches, in which the flow of water is permanent, intermittent, or temporary.

822.05 MATERIALS

822.05.01 General

Rocky ramps shall be constructed in the dry.

822.05.01 Streambed Material

Streambed material shall be according to OPSS 1005 and as specified in the Contract Documents.

822.07 CONSTRUCTION

822.07.01 General

Rocky ramps shall be installed in the dry.

822.07.02 Removal of In-Stream Obstructions to Fish Passage from Waterbodies

Pre-existing, in-stream obstructions to fish passage shall be removed from the waterbody as specified in the Contract Documents.

822.07.03 Channel Excavation

Prior to construction of rocky ramps, the streambed shall be graded to create the slope and pools as specified in the Contract Documents.

The top layer of the excavated streambed material shall be stockpiled on-site and reused later as the top layer of the rocky ramp as specified in the Contract Documents.

822.07.04 Streambed Material

All imported streambed material shall be stockpiled within graded piles on-site adjacent to the rocky ramp construction location.

The downstream end of the rocky ramp shall be flatter than the rest of the ramp, approximately 10H: 1V or as specified in the Contract Documents.

Streambed material placement shall commence at the downstream end of the waterbody as specified in the Contract Documents and progress to the upstream end. Streambed material shall be placed first in the centre of the boulder weir crest and then outwards toward the waterbody banks.

Each boulder weir shall be shaped like an arch so that adjacent streambed materials support each other along the length of the boulder weir. Individual pieces of streambed material shall be carefully placed in a manner that allows the material to be rotated for precise alignment and fitting during construction.

Anchor stones shall form the first layer of streambed material and be placed below the elevation of the final grade to support a second row of streambed material.

The top row of streambed material shall then be placed against the anchor stones and slightly upstream of them so that they are supported with multiple points of contact.

When the arch of the boulder weir is complete, each boulder shall bear against its downstream neighbour and against the two anchor stones below it.

Anchor stones shall also be placed at the ends of each boulder weir well into the waterbody banks to the high water level and backfilled as specified in the Contract Documents.

Each pool shall be lined with streambed material as specified in the Contract Documents.

The bottom of each subsequent boulder weir shall be equal to the elevation of the crest of the boulder weir immediately downstream as specified in the Contract Documents.

Well-graded streambed material with some fines shall be placed on the upstream side of the boulder weir as specified in the Contract Documents.

Upon completion of construction of the rocky ramp, the center stone of each boulder weir crest shall be removed to form a notch for a low flow channel.

822.07.05 Protection of Waterbodies and Waterbody Banks

Protection of waterbodies and waterbody banks shall be according to the Contract Documents.

822.07.06 Temporary Flow Control for Construction in Waterbodies

Temporary flow control for construction in waterbodies shall be according to the Contract Documents.

822.07.07 Management of Excess Materials

Management of excess materials shall be according to the Contract Documents.

822.09 MEASUREMENT FOR PAYMENT

822.09.01 Actual Measurement

822.09.01.01 Rocky Ramps

Measurement for rocky ramps shall be by horizontal area in square metres.

822.10 BASIS OF PAYMENT

822.10.01 Rocky Ramps - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

Appendix 822-A, November 2014
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Streambed material. (822.05.01)

- Pre-existing in-stream obstructions to fish passage to be removed. (822.07.02)

- The location, dimensions, and slope of the rocky ramps on the streambed at the Contract site. (822.07.03)

- The gradation of the various components of streambed material including anchor stones according to OPSS 1005 required to construct the rocky ramps that are suitable to the Contract site. (822.07.04)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 222.070 Rocky Ramps on Streambeds

ONTARIO PROVINCIAL STANDARD SPECIFICATION

METRIC
OPSS 823
APRIL 2017
(Formerly OPSS 823, November 2014)

Note: The MUNI implemented in April 2017 replaces OPSS 823 COMMON, November 2014 with no technical content changes.

CONSTRUCTION SPECIFICATION FOR LOW FLOW CHANNELS

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823.07 **CONSTRUCTION**

823.08 **QUALITY ASSURANCE - Not Used**

823.09 **MEASUREMENT FOR PAYMENT**

823.10 **BASIS OF PAYMENT**

APPENDICES

823-A **Commentary**

823.01 SCOPE

This specification covers the requirements for the construction of low flow channels to maintain and enhance fish passage in a waterbody or a culvert.

823.01.01 Specification Significance and Use

This specification has been developed for use in municipal oriented Contracts. The administration, testing, and payment policies, procedures, and practices reflected in this specification correspond to those used by many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

823.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

823.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Materials

OPSS 1005 Aggregates - Streambed Material

Canadian and Provincial Statutes

Fisheries Act, R.S.C., 1985, c. F-14, as amended
Ontario Water Resources Act, R.S.O. 1990, c. 0.40, as amended

823.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Low Flow Channel means the part of a streambed occupied by water during periods of low flow.

Streambed means the bottom of the channel where a watercourse flows.

Streambed Material means the material that rests at the bottom of a waterbody and typically consists of natural sand, gravel, cobble, and boulders.

Waterbody means any permanent or intermittent, natural or constructed body of water, including lakes, ponds, wetlands, and watercourses, but does not include sewage works as defined in the Ontario Water Resources Act.

Watercourse means a stream, creek, river, or channel including ditches, in which the flow of water is permanent, intermittent, or temporary.

823.05 MATERIALS

823.05.01 Streambed Material

When the installation of a low flow channel includes supply of streambed material, it shall be according to OPSS 1005 and as specified in the Contract Documents.

823.07 CONSTRUCTION

823.07.01 General

Low flow channels shall be installed in the dry.

Excavation of the streambed and supply of streambed material from off-site may not be required if the existing streambed material can be adjusted to create the required low flow channel as specified in the Contract Documents.

When excavation of the streambed and supply of streambed material are required to achieve the design as specified in the Contract Documents, any materials that are suitable for reuse that must be temporarily removed from the streambed shall be stored on-site as specified in the Contract Documents.

823.07.02 Low Flow Channel

Once the streambed has been prepared, streambed material according to OPSS 1005 shall be installed as specified in the Contract Documents.

Streambed material placement shall be adjusted as necessary to achieve the design as specified in the Contract Documents.

Proper function shall be verified to ensure the flow is contained within the low flow channel, as constructed, when water is returned to the channel and that the grade and transition areas from the low flow channel to the waterbody do not present any barriers to flow or fish passage or direct flow outward towards the waterbody banks.

Streambed material placement may need to be adjusted to rectify any of these conditions.

823.07.03 Protection of Waterbodies and Waterbody Banks

Protection of waterbodies and waterbody banks shall be according to the Contract Documents.

823.07.04 Temporary Flow Control for Construction in Waterbodies

Temporary flow control for construction in waterbodies shall be according to the Contract Documents.

823.07.05 Management of Excess Materials

Management of excess materials shall be according to the Contract Documents.

823.09 MEASUREMENT FOR PAYMENT

823.09.01 Actual Measurement

823.09.01.01 Low Flow Channel

Measurement of low flow channels using existing streambed material shall be in linear metres installed.

Measurement of low flow channels that include supply of streambed material shall be by mass in tonnes of streambed material.

823.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

823.10 BASIS OF PAYMENT

823.10.01 Low Flow Channel - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

Appendix 823-A, November 2014
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Streambed material. (823.05.01)

- When supply of streambed material is required to construct low flow channels. (823.07.01)

- The gradation of the various components of streambed material according to OPSS 1005 required to construct the low flow channels that are suitable to the Contract site. (823.07.02)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPS D222.080 Low Flow Channel

ONTARIO PROVINCIAL STANDARD SPECIFICATION

METRIC
OPSS 824
APRIL 2017
(Formerly OPSS 824, November 2014)

Note: The MUNI implemented in April 2017 replaces OPSS 824 COMMON, November 2014 with no technical content changes.

CONSTRUCTION SPECIFICATION FOR BAFFLES IN A CULVERT

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824-A **Commentary**

824.01 SCOPE

This specification covers the requirements for the construction of baffles in culverts using streambed material to direct the flow of water within the culverts and to enhance fish passage through the culverts.

824.01.01 Specification Significance and Use

This specification has been developed for use in municipal oriented Contracts. The administration, testing, and payment policies, procedures, and practices reflected in this specification correspond to those used by many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

824.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

824.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Materials

OPSS 1005 Aggregates - Streambed Material

Canadian and Provincial Statutes

Fisheries Act, R.S.C., 1985, c. F-14, as amended
Ontario Water Resources Act, R.S.O. 1990, c. 0.40, as amended

824.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Baffle means one or a series of partial obstructions in a channel designed to increase flow depth or dissipate the energy of water flowing at high velocity while at the same time providing fish passage.

Culvert means a structure that provides an opening through an embankment and to which roadway loads are distributed through fill or that is designated as a culvert in the Contract Documents.

Deleterious Substance means as defined in the Fisheries Act.

Low Flow Channel means the part of a streambed occupied by water during periods of low flow.

Streambed means the bottom of the channel where a watercourse flows.

Streambed Material means the material that rests at the bottom of a waterbody and typically consists of natural sand, gravel, cobble, and boulders.

Waterbody means any permanent or intermittent, natural or constructed body of water, including lakes, ponds, wetlands, and watercourses, but does not include sewage works as defined in the Ontario Water Resources Act.

Watercourse means a stream, creek, river, or channel including ditches, in which the flow of water is permanent, intermittent, or temporary.

824.05 MATERIALS

824.05.01 Streambed Material

Streambed material used to construct baffles in a culvert shall be according to OPSS 1005 and as specified in the Contract Documents.

824.07 CONSTRUCTION

824.07.01 General

All baffles shall be constructed in the dry.

824.07.02 Baffles in a Culvert

Baffles shall be installed in a culvert to be a permanent feature within the culvert as specified in the Contract Documents.

When the construction of the baffles in a culvert is complete and the waterbody flow has been reinstated, streambed material placement shall be adjusted by hand to achieve the design specified in the Contract Documents.

The baffles in a culvert shall be monitored after installation is complete to verify that the grade and transition of flow to the low flow channel within the culvert does not present any barriers to fish passage.

The placement of streambed material shall be adjusted to rectify any barriers to fish passage.

824.07.03 Protection of Waterbodies and Waterbody Banks

Protection of waterbodies and waterbody banks shall be according to the Contract Documents.

824.07.04 Temporary Flow Control for Construction in Waterbodies

Temporary flow control for construction in waterbodies shall be according to the Contract Documents.

824.07.05 Management of Excess Materials

Management of excess materials shall be according to the Contract Documents.

824.09 MEASUREMENT FOR PAYMENT

824.09.01 Actual Measurement

824.09.01.01 Baffles in a Culvert

For measurement purposes, a count shall be made of the number of baffles installed in a culvert.

824.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

824.10 BASIS OF PAYMENT

824.10.01 Baffles in a Culvert - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

Appendix 824-A, November 2014
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

- The designer should specify the following in the Contract Documents:

- The gradation of the various components of streambed material as specified in OPSS 1005 required to construct the baffles in the culverts that are suitable to the Contract site. (824.05.01)

- Any other materials required to form the base of the baffles.

The designer should consider the following and specify it in the Contract Documents:

- The use of baffles in culverts should be limited to retrofit situations only.

- Whereas, baffles can be used to direct and reduce flow velocity in a culvert where it may be too high for fish passage, it must be verified that the hydraulics and flow carrying capacity of the culverts are sufficient to accommodate the altered flow that baffles will produce, when specifying their use in a Contract using this specification.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 222.090 Baffles in a Culvert

Note: The MUNI implemented in April 2017 replaces OPSS 830 COMMON, November 2015 with no technical content changes.

CONSTRUCTION SPECIFICATION FOR LOCAL SEED BANK

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830.09 **MEASUREMENT FOR PAYMENT**

830.10 **BASIS OF PAYMENT**

APPENDICES

830-A **Commentary**

830.01 SCOPE

This specification covers the requirements for the installation of local seed banks.

830.01.01 Specification Significance and Use

This specification has been developed for use in municipal oriented Contracts. The administration, testing, and payment policies, procedures, and practices reflected in this specification correspond to those used by many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

830.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

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The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

830.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 206 Grading

Ontario Ministry of the Environment and Climate Change Publications

Ontario Water Resources Act, - R.S.O. 1990, c O.40

830.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Normal Water Level means the average water level that occurs between high water level events or periods and low water level events or periods.

Local Seed Bank means all the seeds existing in the highest quality topsoil, stripped from the top 100 - 300 mm of the site, in a riparian vegetation area containing species native to the project site.
Riparian Vegetation Areas means vegetation areas within 30 m of the top of a waterbody bank.

Waterbody means any permanent or intermittent, natural or constructed body of water including lakes, ponds, wetlands and watercourses, but does not include sewage works as defined in the Ontario Water Resources Act.

Waterbody Bank means the slope on or adjacent to a waterbody from the normal water level to the top of slope.

Watercourse means a stream, creek, river, or channel including ditches, in which the flow of water is permanent, intermittent, or temporary.

830.05 MATERIALS

830.05.01 Local Seed Bank

Local seed bank shall be sourced on-site from existing topsoil in riparian vegetation areas removed to a depth as specified in the Contract Documents.

830.07 CONSTRUCTION

830.07.01 Salvaging Seed Bank

Removal of local seed bank shall occur by the removal of the topsoil layer prior to any other construction activities occurring within the areas specified in the Contract Documents.

Areas designated to have seed bank salvaged shall be excavated to a depth of 50 – 300 mm.

Areas that show evidence of non-native or invasive species shall not be used.

830.07.02 Seed Bank Stockpiles

The collected local seed bank shall be stockpiled in the locations specified in the Contract Documents.

Stock piles should not exceed 1500 mm in height. Avoid compacting the seedbank stockpiles. If possible strip and spread on receiving sites immediately, If stored, Storage shall be for less than 6 months. Cover with tarps or woven geotextile material to prevent soil erosion and contamination by weeds during storage. Alternatively, topsoil stockpiles can be stabilized by temporarily establishing groundcover vegetation composed of non-invasive species. Installation of ground cover seeds shall be by application of seeded compost or seeded biodegradable mats.

Surround stockpile with silt fencing or compost filter socks.

No machinery shall be allowed on the top of any stockpiles.

Local seed bank stockpiles are to be kept moist to prevent drying of seeds.

D. 830.07.03 Installation

Application of stockpiled local seed bank to the areas specified in the Contract Documents shall occur during the growing season (May – September).

The areas to be treated with local seed bank shall be graded prior to placement according to OPSS 206. Scarification to a depth of 150 mm is required prior to placement. Apply topsoil to a depth of 150 mm. The stockpiled local seed bank shall be spread out in an even layer ontop of the topsoil to a thickness of 150 mm.

If any areas treated with local seed bank is subsequently re-graded for any reason, local seed bank shall be re-collected and re-applied according to this specification. Should local seed bank no longer be available, the area should be reseeded with a seed mix specified by the Contract Administrator

830.07.04 Protection of Waterbodies and Waterbody Banks

Protection of waterbodies and waterbody banks shall be according to the Contract Documents.

830.07.05 Management of Excess Materials

Management of excess materials shall be according to the Contract Documents.

830.09 MEASUREMENT FOR PAYMENT

830.09.01 Actual Measurement

830.09.01.01 Local Seed Bank

Measurement of local seed bank shall be by area in square metres.

804.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

830.10 BASIS OF PAYMENT

830.10.01 Local Seed Bank – Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

Appendix 830-A, November 2015
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

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Designer Action/Considerations

The following should be specified in the Contract Documents:

- Specify the removal depth of existing topsoil in riparian vegetation areas (830.05.01)
- Natural heritage survey to identify evidence of a native seed bank; (830.07.01)
- Specify the location(s) where local seed bank is to be sourced on-site; (830.07.01)
- Specify the duration and location(s) of where local seed bank is to be stockpiled on-site; (830.07.01)
- Specify the locations where local seed bank is to be installed on-site; (830.07.04)
- Specify the thickness of spread local seed bank stockpile. (830.07.04)
- Specify erosion and sediment control measures as necessary to protect waterbodies during grading and installation of local seed bank. (830.07.05)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

CONSTRUCTION SPECIFICATION FOR LOCAL VEGETATION BLOCKS

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APPENDICES

831-A Commentary

831.01 SCOPE

This specification covers the requirements for the installation of local vegetation blocks on waterbody banks.

831.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

831.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

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831.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, General

OPSS 206 Grading
OPSS 804 Seed and Cover

Ontario Provincial Legislation

Invasive Species Act, 2015, as amended
Ontario Water Resource Act, 1990, as amended

831.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

High Water Level means the highest point on the bank or floodplain of a waterbody where the water level reaches during high flow events or periods.

Local Vegetation Blocks means a salvaged layer of topsoil with densely rooted grass and herbaceous material with an intact root structure.

Low Water Level means the lowest point on the bank or steam bed of a waterbody where the water level recedes to during low flow events or periods.

Establishment means a period of thirty days after installation to allow for evidence that vegetation is alive and thriving.

Invasive Species means as in the Invasive Species Act, 2015

Local Vegetation Blocks means a salvaged layer of topsoil with densely rooted grass and herbaceous material with an intact root structure.

Normal Water Level means the average water level that occurs between high water level events or periods and low water level events or periods.

Waterbody means any permanent or intermittent, natural or constructed body of water including lakes, ponds, wetlands and watercourses, but does not include sewage works as defined in the Ontario Water Resources Act.

Waterbody Bank means the slope on or adjacent to a waterbody from the normal water level to the top of slope.

Watercourse means a stream, creek, river, or channel including ditches, in which the flow of water is permanent, intermittent, or temporary.

831.05 MATERIALS

831.05.01 Local Vegetation Blocks

Local vegetation blocks shall be solid enough to be salvaged mechanically, transported and stored on-site prior to installation as specified in the Contract Documents without deteriorating.

Local vegetation blocks shall be sourced on-site from locations specified in the Contract Documents.

Local vegetation blocks shall not contain prohibited or restricted invasive species.

831.07 CONSTRUCTION

831.07.01 Waterbody Bank Preparation

The waterbody bank shall be graded and prepared prior to placement of the local vegetation blocks as specified in the Contract Documents and according to OPSS 206. Material from the waterbody bank shall not enter the waterbody during grading.

831.07.02 Local Vegetation Block Installation

Removal of local vegetation blocks shall occur prior to any other construction activities.
Local vegetation blocks shall only be salvaged and placed from April to October excluding the months of July and August.

Stockpiled local vegetation blocks shall be kept moist and free from any vehicle damage until installation.

Local vegetation blocks shall be secured in place with wooden stakes in areas specified in the Contract Documents. Additional wooden stakes shall be used as required to secure the blocks in place.

Local vegetation blocks shall be placed the same day or stored as follows:

a) Stacked on top of each other (no more than 2 high) and kept moist for a maximum of three days; and

b) Laid out on an impermeable surface and kept watered if stored more than three days.

Local vegetation blocks shall be salvaged as near as possible to the area where they are to be installed. Once installed, local vegetation blocks shall be kept moist until establishment.

831.07.03 Protection of Waterbodies and Waterbody Banks

Protection of waterbodies and waterbody banks shall be according to the Contract Documents.

831.07.04 Management of Excess Materials

Management of excess materials shall be according to the Contract Documents.

831.08 QUALITY ASSURANCE

831.08.01 Acceptance

Local vegetation blocks shall be accepted when they have securely rooted to the ground beneath and show no evidence of browning or slipping by establishment. Local vegetation blocks shall otherwise be replaced or reseeded according to OPSS 804 as directed by the Contract Administrator.

831.09 MEASUREMENT FOR PAYMENT

831.09.01 Actual Measurement

831.09.01.01 Local Vegetation Blocks

Measurement of local vegetation blocks shall be by area in square metres.

831.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

831.10 BASIS OF PAYMENT

831.10.01 Local Vegetation Blocks Salvage and Installation – Item
Local Vegetation Blocks Establishment - Item
Local Vegetation Blocks Acceptance - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material required to do the work.

Contract tender item price for Local Vegetation Blocks Establishment shall be a minimum of 30% of the tender item price for Local Vegetation Blocks Salvage and Installation.

Contract tender item price for Local Vegetation Blocks Acceptance shall be a minimum of 20% of the tender item price for Local Vegetation Blocks Salvage and Installation.

Local Vegetation Blocks Establishment shall be paid prior to Local Vegetation Blocks Acceptance.

Appendix 831-A, November 2017
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The design should specify the following in the Contract Documents:

- The on-site location(s) where local vegetation blocks are to be sourced. (831.05.01)

- Extent and location(s) of where local vegetation blocks are to be stored on-site. (831.05.01)

- Areas where local vegetation blocks are to be installed on waterbody banks. (831.07.02)

- Include all three items in the form of tender. (831.10.01)

The designer should ensure that the Ontario Provincial Standards General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 222.100 Local Vegetation Blocks

CONSTRUCTION SPECIFICATION FOR BIOENGINEERING MEASURES

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832.08 **QUALITY ASSURANCE**

832.09 **MEASUREMENT FOR PAYMENT**

832.10 **BASIS OF PAYMENT**

APPENDICES

832-A **Commentary**

832.01 SCOPE

This specification covers the requirements for the installation of bioengineering measures for soil stabilization.

832.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

832.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

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832.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Ministry of Environmental and Climate Change

Ontario Water Resources Act, R.S.O. 1990, c. O40

832.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Bioengineering Measures means plant material such as live fascines and live stakes, brush layers and brush mattresses applied to waterbody banks to stabilize and prevent waterbody bank failure.

Brush Layer means layers of live cuttings placed on a terrace along contours of a waterbody bank interspersed between layers of soil.

Brush Mattress means a combination of live stakes, live fascines and live cuttings installed in layers on a waterbody bank to form a living ground cover.

Establishment means a period of thirty days after installation to allow for evidence that bioengineering measures are alive and thriving.

High Water Level means the highest point on the bank or floodplain of a waterbody where the water level reaches during high flow events or periods.

Live Cuttings means portions cut from dormant, live plants, with branches left on, of a specified woody species that is neither exotic nor invasive, to make live fascines, brush layers, and brush mattresses.

Live Fascines means live cuttings bound together to form a cylindrical structure.

Live Stakes means dormant, live cuttings with the branches trimmed off.

Low Water Level means the lowest point on the bank or steam bed of a waterbody where the water level recedes to during low flow events or periods.

Normal Water Level means the average water level that occurs between high water level events or periods and low water level events or periods**.**

Waterbody means any permanent or intermittent, natural or constructed body of water including lakes, ponds, wetlands and watercourses, but does not include sewage works as defined in the Ontario Water Resources Act.

Waterbody Bank means the slope on or adjacent to a waterbody from the normal water level to the top of slope.

Watercourse means a stream, creek, river, or channel including ditches, in which the flow of water is permanent, intermittent, or temporary.

832.05 MATERIALS

832.05.01 Live Cuttings

Live cuttings shall be from dormant, indigenous plants sourced from within the Working Area hardiness zone or shall be as specified in the Contract Documents.

Live cuttings shall be free of disease and damage.

When live cuttings are bundled they shall be tied with twine so that they do not fall apart when handled.

Live cutting dimensions shall be as specified in the Contract Documents.

832.05.03 Twine

Twine shall be inert and biodegradable.

832.07 CONSTRUCTION

832.07.01 Operational Constraints

Bioengineering measures shall not be installed during extended rainfall events that cause saturation of soils.

Excavated materials that are suitable for reuse as backfill material shall be stockpiled on-site and controlled as specified in the Contract Documents.

Live cuttings shall be installed within 12 hours of collection on-site or arrival from a supplier, or shall otherwise be stored according to this specification.

Live cuttings shall not be installed if buds have broken open or if they are split, dried out, sprouting, or moldy.

832.07.02 Collection, Transport and Storage of Live Cuttings and Live Stakes

832.07.02.01 Collection

Sharp, clean hand tools shall be used for harvesting live cuttings.

Live cuttings collected on-site shall be taken from the crown of plants that have closed buds present with attached side branches and bark left intact. No more than 2/3 of the existing plant shall be removed.

832.07.02.02 Transport

The temperature during transportation of live cuttings and live stakes shall be maintained as uniformly as possible by mechanical or other means.

832.07.02.03 Storage

When live cuttings or live stakes cannot be installed within 12 hours of collection on-site or arrival from a supplier, they shall be stored with the cut ends in water, in bags with damp soil, or if frozen, in a small amount of snow. After two weeks new live cuttings or live stakes must be collected or obtained from a supplier and the old ones disposed of as specified in the Contract Documents.

832.07.03 Preparation and Installation

832.07.03.01 Live Fascines

Once the live fascines are prepared according to the Contract Documents they shall be installed immediately according to the following steps:

a) A trench shall be dug as specified in the Contract Documents.

b) The live fascines shall be installed by hand into the ground and anchored with wooden stakes.

c) The trench shall be backfilled with the stockpiled excavated material as specified in the Contract Documents.

d) If multiple live fascines are installed, this process shall be repeated starting at the bottom of the slope and progressing upwards.

e) Soil around all live fascines shall be kept moist until establishment of roots and shoots.

832.07.03.02 Live Stakes

Live stakes shall be installed the day that they are collected or removed from storage. Live stakes shall be installed as specified in the Contract Documents and according to the following steps:

a) Live stakes shall be installed by hand into the ground. The soil surrounding the live stakes shall be tamped down firmly. In soils that are firm, pilot holes shall be made by driving a steel rod into the ground.

b) Soil around all live stakes shall be kept moist until establishment of roots and shoots.

832.07.03.03 Brush Mattress

Brush mattress shall be installed as specified in the Contract Documents and according to the following steps:

a) A shallow trench shall be excavated on the slope of the waterbody bank as specified in the Contract Documents.

b) Live fascines shall be placed into the trench and staked into the ground as specified in the Contract Documents.

c) Once the twine is secure, the wooden stakes shall be tamped into the ground by hand until the live stakes are securely held to the waterbody bank.

d) Voids between the live stakes in the trench shall be filled with a layer of stockpiled excavated material and tamped down by hand.

e) The surface of the brush mattress shall be watered to wash the stockpiled excavated material down in between the live stakes leaving the top surface of the brush mattress and the live fascines slightly exposed.

832.07.03.04 Brush Layers

Live cuttings shall be installed the same day that they are collected or removed from storage.

The waterbody bank shall be excavated and the brush layers installed as specified in the Contract Documents.

832.07.04 Protection of Waterbodies and Waterbody Banks

Protection of waterbodies and waterbody banks shall be as specified the Contract Documents.

832.07.05 Management of Excess Materials

Management of excess materials shall be as specified the Contract Documents.

832.08 QUALITY ASSURANCE

832.08.01 Acceptance

Bioengineering measures shall be accepted when they have securely rooted to the ground beneath and show no evidence of browning or slipping by establishment. Bioengineering measures shall otherwise be replaced or soil stabilized as directed by the Contract Administrator.

832.09 MEASUREMENT FOR PAYMENT

832.09.01 Actual Measurement

832.09.01.01 Live Fascines Installation
Live Stakes Installation

For measurement purposes a count shall be made of the number of live fascines and live stakes installed.

832.09.01.02 Brush Mattress Installation
Brush Layers Installation

Measurement of brush mattress and brush layers shall be by area in square metres following the contours of the ground.

832.10 BASIS OF PAYMENT

832.10.01 Live Fascines Installation – Item
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Live Fascines Acceptance - Item
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Live Stakes Establishment – Item
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Brush Mattress Establishment – Item
Brush Mattress Acceptance - Item
Brush Layers Installation - Item
Brush Layers Establishment – Item
Brush Layers Acceptance – Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

832.10.01.01 Live Fascines

Contract tender item price for Live Fascines Establishment shall be a minimum of 30% of the tender item price for Live Fascines Installation.

Contract tender item price for Live Fascines Acceptance shall be a minimum of 20% of the tender item price for Live Fascines Installation.

Live Fascines Establishment shall be paid prior to Live Fascines Acceptance.

832.10.01.02 Live Stakes

Contract tender item price for Live Stakes Establishment shall be a minimum of 30% of the tender item price for Live Stakes Installation.

Contract tender item price for Live Stakes Acceptance shall be a minimum of 20% of the tender item price for Live Stakes Installation.

Live Stakes Establishment shall be paid prior to Live Stakes Acceptance.

832.10.01.03 Brush Mattress

Contract tender item price for Brush Mattress Establishment shall be a minimum of 30% of the tender item price for Brush Mattress Installation.

Contract tender item price for Brush Mattress Acceptance shall be a minimum of 20% of the tender item price for Brush Mattress Installation.

Brush Mattress Establishment shall be paid prior to Brush Mattress Acceptance.

832.10.01.04 Brush Layers

Contract tender item price for Brush Layers Establishment shall be a minimum of 30% of the tender item price for Brush Layers Installation.

Contract tender item price for Brush Layers Acceptance shall be a minimum of 20% of the tender item price for Brush Layers Installation.

Brush Layers Establishment shall be paid prior to Brush Layers Acceptance.

Appendix 832-A, November 2018

FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- The non-invasive, non-exotic, indigenous species to be used and the areas where they are to be sourced on-site. (832.05.01)

- Trench size(s), fascine diameter(s), fascine length(s), location(s), and spacing. (832.07.03.01)

- Where erosion control blanket is required. (832.07.03.01, 832.07.03.02)

- Where seed or seed and cover is required. (832.07.03.01, 832.07.03.02)

- The length of live stakes to be used for bioengineering measures. (832.07.03.02, 832.07.03.03)

- Locations where live stakes are to be installed on a waterbody bank such that they remain moist during the growing season and will be installed deeply enough to reach the water table during the dry season. (832.07.03.02, 832.07.03.03)

- The spacing pattern for live stakes which should allow for a fluctuating water level. (832.07.03.02, 832.07.03.03)

- Where on the waterbody bank the installation should be started. (832.07.03.04)

- Where seed and cover should be placed with the installation of brush layers. Use seed and mulch between rows on 3:1 or flatter slopes and rolled erosion control blankets or hydraulically applied seed erosion control products on slopes steeper than 3:1. (832.07.03.04)

- Waterbody bank preparation for installation of brush layers and brush mattress shall be designed based on length of slope and type of soil. (832.07.03.04)

Related Ontario Provincial Standard Drawings

OPSD 222.110 Live Fascines
OPSD 222.120 Live Stakes
OPSD 222.130 Brush Mattress
OPSD 222.140 Brush Layers

CONSTRUCTION SPECIFICATION FOR EXCAVATING AND BACKFILLING - STRUCTURES

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902.01 SCOPE

This specification covers the requirements for excavating and backfilling for structures, including dewatering.

902.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

902.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

902.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following specifications, standards, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 206	Grading
OPSS 501	Compacting
OPSS 510	Removal
OPSS 517	Dewatering
OPSS 539	Temporary Protection Systems

Ontario Provincial Standard Specifications, Material

OPSS 1004	Aggregates - Miscellaneous
OPSS 1010	Aggregates - Base, Subbase, Select Subgrade, and Backfill Material
OPSS 1205	Clay Seal
OPSS 1860	Geotextiles

902.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Bedding means granular material to be placed in areas so designated in the Contract Documents.

Certificate of Conformance means a document issued by the Quality Verification Engineer confirming that the specified components of the Work are in General Conformance with the requirements of the Contract Documents.

Channel means a natural or artificial watercourse.

Culvert means a structure that provides an opening through an embankment and to which roadway loads are distributed through fill or that is designated as a culvert in the Contract Documents.

Designated Payment Surface means the original ground surface shown in the Contract Documents, unless a specially designated payment surface is shown either by elevation or by profile. The specially designated payment surface is horizontal in the transverse direction.

For rock excavation the designated payment surface shall be the existing rock surface as established in the field before rock excavation begins, unless another designated payment surface is specified.

Earth means all soils except those defined as rock, and excludes stone masonry, concrete and other manufactured materials.

Engineer means a professional engineer licensed by the Professional Engineers Ontario to practice in the Province of Ontario.

Foundation means that portion of the ground below the structure base or footings that supports the structure or that portion of the ground supporting the pile caps.

Quality Verification Engineer means an Engineer retained by the Contractor qualified to provide the services specified in the Contract Documents.

Rock means natural beds or massive fragments, of the hard, stable, cemented part of the earth's crust, igneous, metamorphic, or sedimentary in origin, which may or may not be weathered, and includes boulders having a volume of 1 cubic m or greater.

Soil means all loose or moderately cohesive organic or inorganic deposits of the earth's crust such as silt, sand, gravel, or clay or any of their mixtures.

Structure means any bridge, tunnel, concrete culvert, retaining wall, dock, guideway, or sign support.

902.04 DESIGN AND SUBMISSION REQUIREMENTS

902.04.01 Design Requirements

902.04.01.01 Dewatering

Where dewatering is required, the Contractor shall be responsible for the design of the dewatering scheme for the intended purpose.

902.04.02 Submission Requirements

902.04.02.01 Preconstruction Survey

Prior to commencing the work, a condition survey of property and structures that may be affected by the work shall be submitted to the Contract Administrator. The survey shall include the locations and conditions of adjacent properties; buildings; underground structures; Utility services; and structures, such as walls abutting the site.

902.04.02.02 Milestone Inspections

The Quality Verification Engineer shall witness the following Interim Inspections of the work:

a) Dewatering of excavation for structure.

b) Completion of excavation for foundation.

c) Excavation for backfill and frost tapers.

d) Backfilling.

A copy of the written permission to proceed shall be submitted to the Contract Administrator prior to commencement of the successive operation.

902.05 MATERIALS

902.05.01 Granular

Granular material to be used for backfill, bedding, and frost tapers shall be according to OPSS 1010.

The 19.0 mm clear stone to be used for wall drains shall be according to OPSS 1004.

902.05.02 Native Backfill

Native and imported material shall be approved by the Contract Administrator. All material shall be free from frozen lumps, cinders, ashes, refuse, vegetable or organic matter, rocks and boulders over 150 mm in any dimension, and other deleterious material.

902.05.03 Clay Seal

Clay seal shall be according to OPSS 1205.

902.05.04 Geotextile

Geotextile shall be according to OPSS 1860 and be of the type, class, and filtration opening size (FOS) range specified in the Contract Documents.

902.06 EQUIPMENT

902.06.01 Compaction Equipment

Compaction equipment shall be according to OPSS 501.

902.07 CONSTRUCTION

902.07.01 Removals

Removals shall be according to OPSS 510.

902.07.02 Removal of Ice and Snow

All ice and snow shall be removed from all portions of the work area before any excavation and backfill operations proceed. Frozen materials shall not be incorporated into the work. Material shall not be placed over frozen ground, ice, or snow.

902.07.03 Protection Systems

Protection systems shall be according to OPSS 539.

Protection systems shall be installed:

a) Where the stability, safety, or function of an existing structure, roadway, railway, or other facility can be impaired by an excavation or temporary slope.

b) To permit excavation where there is a necessity to retain the sidewalls of an excavation and to permit dewatering by restricting water flow and facilitating safe execution of the work.

902.07.04 Dewatering Structure Excavation

Until backfilling has been completed and to permit the placing of concrete in the dry, the Contractor shall carry out all work necessary to control the flow of water into the excavation and to prevent disturbance of the founding material.

Control of water shall be according to OPSS 517.

All temporary dewatering shall remain the property of the Contractor and shall be removed from the right-of-way when they are no longer required.

902.07.05 Excavation

902.07.05.01 General

Deterioration of the foundation soil or rock, surface water from entering and eroding the face of the excavation, and build up of hydrostatic pressures that may have harmful effects upon the temporary or permanent structures shall be prevented.

902.07.05.02 Excavation for Foundations

Excavation for footings, working slabs, and granular pads shall be to the neat lines specified in the Contract Documents.

The bottom of the excavation on which the footing, working slab, or granular pad is to rest shall not be disturbed. In soft conditions, construction of the footing or structural slab shall commence immediately after the final removal of material to the foundation level has been completed.

In the case of concrete culverts of the open footing type, no excavation shall be made between the footings below the level of the stream bed or the top of the footings, whichever elevation is lower, unless authorized in writing by the Contract Administrator.

The elevation of the bottom of the footing, working slab, or granular pad shall not be changed without the approval of the Contract Administrator.

Overexcavated areas shall be restored to their original conditions. Overexcavated areas shall be backfilled with a material suitable for the particular application and approved by the Contract Administrator. Concrete fill shall be used for overexcavation in rock. Where material other than concrete is used, the material shall be compacted to the dry density specified in OPSS 501.

When authorized by the Contract Administrator, additional excavation, as may be required, shall be carried out.

902.07.05.03 Excavation for Backfill and Frost Tapers

Excavation for backfill and frost tapers shall be to the neat lines specified in the Contract Documents.

Overexcavated areas shall be restored with material approved by the Contract Administrator. The material shall be compacted to the dry density specified in OPSS 501.

902.07.05.04 Preservation of Channel

Where a channel cross-section is altered, it shall be restored to its original condition.

902.07.06 Backfilling

902.07.06.01 General

Frozen materials shall not be incorporated into the work.

Footings shall be protected against frost action.

Other than the backfill placed to the tops of the footings, no fill shall be placed against an abutment, wingwall, retaining wall, or concrete culvert until the concrete has reached 70% of its design strength.

Backfilling around culverts, arches, rigid frames, and piers shall proceed simultaneously and evenly on both sides of the structure. The differential in surface elevation of the backfill material on each side of the structure and individual component shall not be greater than 500 mm.

All voids around abutments, piers, or other permanent work shall be backfilled to the level of the surrounding ground or to the grade specified in the Contract Documents, whichever is the lower before the general backfilling commences.

When rock fill is to be placed around a structure the structure shall be protected to prevent damage from the rock fill.

The minimum height of fill specified in the Contract Documents shall be placed before traffic or construction equipment shall pass over the culvert.

Granular material shall be placed within the lines and grades specified in the Contract Documents.

Wall drains shall have a 0.05 m^3 pocket of 19 mm minimum size clear stone wrapped in geotextile placed over the opening of the wall drain at the backfilled side of the wall.

902.07.06.02 Compaction

Backfill shall be placed according to OPSS 206 and compacted according to OPSS 501.

Only hand operated vibratory type compaction equipment shall be used for compaction of fill material within the restricted zone behind all earth retaining structures.

902.07.07 Clay Seal

When specified in the Contract Documents, clay seals shall be placed to the dimensions shown.

902.07.08 Certificate of Conformance

A completed Certificate of Conformance shall be submitted to the Contract Administrator upon completion of the work. The Qualification Verification Engineer's seal and signature shall be affixed on the completed Certificate of Conformance confirming that the work has been carried out in general conformance with the Contract Documents.

902.07.09 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

902.09 MEASUREMENT FOR PAYMENT

902.09.01 Actual Measurement

902.09.01.01 Excavation for Structure

Measurement of earth or rock excavation for structure shall be by volume in cubic metres.

Measurement of excavation for footings shall be based on the neat horizontal dimensions of the footing to the depth of the bottom of the footing, working slab, or granular pad.

Except as noted below, the quantity of excavation shall include only the quantities below the designated payment surface within the neat lines specified in the Contract Documents.

The above measurement also includes:

a) Removal of asphalt pavement, except where there is a separate tender item for pavement removal that includes pavement overlapping the area of structure excavation.

b) The excavation quantities, below the designated payment surface, required for placing granular backfill and granular frost tapers.

c) For open footing culverts, the excavation quantities as measured below the designated payment surface but between the plan areas of the footings and above the stream bed or the tops of the footings, whichever is higher.

Where the structure excavation overlaps excavation required for other work, the measurement shall be made as specified in the Contract Documents with no deductions for overlap.

The volume of boulders in an excavation shall be calculated from the three maximum rectilinear dimensions. The following provisions shall apply:

a) Only the amount removed shall be considered for payment.

b) The volume of the boulders removed shall be deducted from the volume of excavation as calculated above.

The measurement of the total volume of materials considered for payment shall not exceed the calculated volume of excavation within the theoretical lines.

902.09.01.02 Granular Backfill

Measurement for payment of granular backfill shall be by volume in cubic metres or tonnes as specified in the Contract Documents.

The quantity of granular backfill and granular bedding shall include only those quantities measured below the subgrade and as measured within the theoretical line and grades specified in the Contract Documents.

Where the Contractor has excavated beyond the limits specified in the Contract Documents, the conversion factor of 2 t/m^3 shall be used in measurement of the excess volume when it is replaced with granular on a tonne basis.

The weighing of granular material supplied on a tonnage basis shall be according to the Contract Documents.

902.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

902.10 BASIS OF PAYMENT

902.10.01 Earth Excavation for Structure - Item
Rock Excavation for Structure - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

When the Contract Administrator requests excavation for concrete working slabs, granular working pads, or granular bedding, payment shall be at the Contract price for the type of excavation required.

902.10.02 Dewatering Structure Excavations - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

902.10.03 Granular Backfill to Structure - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material required to do the work.

When the Contract Documents do not include a separate item for granular backfill to structure, the Contract price for the items directly associated with the granular backfill to structure shall be full compensation for all labour, Equipment, and Material required to do the work.

902.10.04 Clay Seal - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

902.10.05 Overexcavation

Payment shall not be made for overexcavation that has not been approved by the Contract Administrator or for backfill restoration of such overexcavation.

Appendix 902-A, November 2021
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Geotextile requirements. (902.05.04)

- Neat lines of excavations for footings, working slabs, and granular pads. (902.07.05.02)

- Neat lines of excavation for backfill and frost tapers. (902.07.05.03)

- Grade of backfill around abutments, piers, and other permanent work. (902.06.01)

- Lines and grades for granular materials. (902.06.01)

- Measurement units for granular material. (902.09.01.02)

The designer should determine if the following is required and, if so, it should be specified in the Contract Documents:

- Clay seals and dimensions for clay seals. (902.07.07)

OPSS 902 contains information written for provincial contracts. To ensure completeness of municipal Contract Documents, the designer should invoke Appendix 902-B. The appendix contains supplemental requirements that modify OPSS 902 so it can be used by a municipality in its contracts.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 3090.100	Foundation, Frost Penetration Depths for Northern Ontario
OPSD 3090.101	Foundation, Frost Penetration Depths for Southern Ontario
OPSD 3101.150	Walls, Abutment, Backfill, Minimum Granular Requirement
OPSD 3101.200	Walls, Abutment, Backfill, Rock
OPSD 3102.100	Walls, Abutment, Backfill Drain
OPSD 3120.100	Walls, Retaining, Concrete Toe Wall
OPSD 3121.150	Walls, Retaining, Backfill, Minimum Granular Requirement
OPSD 3190.100	Walls, Retaining and Abutment, Wall Drain

Appendix 902-B, November 2021
FOR USE IN MUNICIPAL CONTRACTS, WHEN REFERENCED IN THE CONTRACT DOCUMENTS

Note: This is a non-mandatory Additional Information Appendix intended to provide supplementary requirements for the OPS specification in a municipal contract, when the appendix is invoked by the Owner. It is written in mandatory language to permit invoking it by reference in the Contract Documents. If the appendix has not been invoked by reference in the Contract Documents, it does not apply.

Supplemental Requirements for Using OPSS.MUNI 902 in Municipal Contracts

OPSS.MUNI 902 Excavation and Backfilling - Structures, is amended as follows:

902.03 Definitions

Section 902.03 is amended by the deletion of the definitions for Certificate of Conformance and for Quality Verification Engineer.

902.04.02.02 Milestone Inspections

Clause 902.04.02.02 is deleted in its entirety and replaced with the following:

The Contract Administrator shall witness the following interim inspections of the work:

a) Dewatering of excavation for structure.

b) Completion of excavation for foundation.

c) Excavation for backfill and frost tapers.

d) Backfilling.

The next operation shall not proceed until the Contract Administrator has examined the excavation and given approval in writing to perform subsequent work.

902.07.04 Dewatering Structure Excavation

The third paragraph of clause 902.07.04 is deleted in its entirety and replaced with the following:

After the dewatering, the excavation shall be inspected and accepted by the Contract Administrator prior to construction of the footing. The Contractor shall not proceed with subsequent work until the Contract Administrator has given permission in writing.

902.07.08 Certificate of Conformance

Subsection 902.07.08 is deleted in its entirety.

CONSTRUCTION SPECIFICATION FOR DEEP FOUNDATIONS

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903.08 **QUALITY ASSURANCE - Not Used**

903.09 **MEASUREMENT FOR PAYMENT**

903.10 **BASIS OF PAYMENT**

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903-A **Commentary**

903.01 SCOPE

This specification covers the requirements for the supply and installation of deep foundation units.

903.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

903.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

903.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 904	Concrete Structures
OPSS 905	Steel Reinforcement for Concrete
OPSS 909	Prestressed Concrete - Precast members
OPSS 911	Coating Structural Steel Systems

Ontario Provincial Standard Specifications, Material

OPSS 1302	Water
OPSS 1350	Concrete - Materials and Production
OPSS 1440	Steel Reinforcement for Concrete

CSA Standards

G40.20-13/G40.21-13 (R2018)	General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel
O56-10 (R2020)	Round Wood Piles
O80 Series-08 (R2012)	Wood Preservation
W47.1-09 (R2014)	Certification of Companies for Fusion Welding of Steel
W59-18	Welded Steel Construction (Metal Arc Welding)
W178.1-18	Certification of Welding Inspection Organizations
W178.2-18	Certification of Welding Inspectors

Canadian General Standards Board (CGSB)

48.9712-2014 Non-destructive Testing - Qualification and Certification of NDT Personnel

ASTM International

A252/A252M-19	Welded and Seamless Steel Pipe Piles
A328/A328M-13a(2018)	Steel Sheet Piling
D1143/D1143M-07(2013)e1	Standard Test Methods for Deep Foundations Under Static Axial Compressive Load
D3689/D3689M-07(2013)e1	Standard Test Methods for Deep Foundations Under Static Axial Tensile Load
D3966/D3966M-07(2013)e1	Standard Test Method for Deep Foundations Under Lateral Load

American Petroleum Institute (API)

API 13A	Drilling Fluid Materials, 17th Edition, 10.00.08
RP 13B-1	Standard Procedure for Field Testing Water Based Drilling Fluids, 5th Edition

Steel Structures Painting Council (SSPC)

NACE No.2/SSPC-SP10(R2006) Near-White Blast Cleaning

International Organization for Standardization/International Electrotechnical Commission (ISO/IEC)

17025:2017 General Requirements for the Competence of the Testing and Calibration Laboratories

903.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Anvil means the component of a diesel hammer that acts as an impact block for the ram

Bedrock means a natural solid bed of the hard, stable, cemented part of the earth's crust, igneous, metamorphic, or sedimentary in origin that may or may not be weathered.

Caisson Pile means a cast in place deep foundation unit with or without an enclosing liner formed by placing concrete in a bored or excavated hole.

Cap Block means a material placed on top of the helmet to cushion the blow of the hammer and to attenuate the peak impact energy without causing excessive loss of the impact energy.

Casing means open ended enclosing cylindrical steel tubing or pipe permanently installed in the ground. Casings are structurally required and can be used to stabilize and excavated hole.

Deep Foundation Unit means a structural member, driven or otherwise, installed in the ground to transfer the loads from a structure to soil or rock and derives supporting resistance from the surrounding soil or rock or from the soil or rock strata below its tip or a combination of both.

Displacement Caisson Pile means a pile formed in the ground by driving a casing or liner with a concrete plug or an expendable metal plate attached to it and replacing the displaced soil with unreinforced or reinforced concrete.

Driven Pile means one of the following pile types: steel H, tube, or sheet piles; wooden pile; or precast reinforced concrete pile that has been installed by means of a pile driver.

Driving Shoe means reinforcement attached to the bottom of the pile and designed to protect the pile during driving or to penetrate into a hard stratum.

Driving to a Set means driving the pile to the requirement that satisfies pile driving criteria correlated to a required pile resistance.

Follower means a removable extension that transmits the hammer blows to the head of the pile.

Helmet means a formed steel cap that fits over the top of a pile head to retain in position a resilient cap block.

Jetting means the use of a jet of water at high pressure directed into the ground below the pile tip to assist its penetration

Liner means open ended enclosing steel tubing or pipe temporarily installed in the ground to facilitate the construction of caisson piles

Pile means a relatively slender structural element that is installed, wholly or partly in the ground by driving, drilling, auguring, jetting, or other means.

Pile Cap means a footing or some other structural component used to transfer the load to the piles as well as maintaining them in position.

Pile Cushion means a pad of resilient material placed between the helmet and the top of a precast reinforced concrete or wooden pile to minimize damage to the head during driving.

Pile Group means the piles supporting a pile cap.

Pumped Concrete means a method of transporting concrete through hose or pipe by means of positive and continuous pressure.

Ram means the moving or driving part of an air, steam, diesel, or drop pile hammer that delivers an impact blow to an anvil and to the pile.

Retapping means verifying that the specified resistance previously attained has been sustained by imparting appropriate hammer energy to the pile and monitoring pile penetration.

Rock Points means a specially designed steel tip fitted to piles to enable them to be driven into hard, sound sloped bedrock.

Sheet Pile means a pile that is designed to interlock with adjacent piles and form a continuous wall for the purpose of resisting mainly lateral forces and to reduce seepage.

Slurry means a drilling fluid, consisting of water mixed with one or more of various solids or polymers, used to maintain the stability of the side walls and bottom of an excavation.

Tremie means a hopper with a vertical pipe used for placing concrete under water. The foot of the pipe is always submerged in concrete except during commencement of concreting and the upper level of the concrete in the pipe is always above water level.

903.04 DESIGN AND SUBMISSION REQUIREMENTS

903.04.01 Design Requirements

903.04.01.01 Concrete

The Contractor is responsible for providing plastic concrete with suitable characteristics for installation. The concrete shall be flow able, non-segregating concrete that does not exhibit rapid slump loss.

903.04.02 Submission Requirements

903.04.02.01 General

All submissions shall bear the seal and signature of an Engineer experienced in the field of deep foundations.

When welded field splices are used, welding procedures according to the Canadian Welding Bureau shall be submitted to the Contract Administrator.

903.04.02.02 Preconstruction Survey

A condition survey of property and structures that may be affected by the work shall be submitted to the Contract Administrator prior to commencing the work. The survey shall include the locations and conditions of adjacent properties; buildings; underground structures; Utility services; and structures, such as walls abutting the site.

903.04.02.03 Materials

903.04.02.03.01 Mill Certificates

One copy of the mill certificates, indicating that the steel meets the requirements for the appropriate standards for H-piles, tube piles, casings, and sheet piles shall be submitted to the Contract Administrator at the time of delivery.

Where mill test certificates originate from a mill outside Canada or the United States of America, the information on the mill certificates shall be verified by testing by a Canadian laboratory. The laboratory shall be certified by an organization accredited by the Standards Council of Canada to comply to comply with the requirements of ISO/IEC 17025 for the specific tests or type of tests required by the material standard specified on the mill test certificate. The mill test certificates shall be stamped with the name of the Canadian testing laboratory and appropriate wording stating that the material conforms to the specified material requirements. The stamp shall include the appropriate material specification number, the date (i.e., yyyy-mm-dd), and the signature of an authorized officer of the Canadian testing laboratory.

903.04.02.03.02 Concrete

A suitable, site-specific concrete mix design that meets the requirements of the hardened concrete shall be submitted to the Contract Administrator 14 Days prior to construction, for information purposes only.

903.04.02.03.03 Slurry

The following shall be submitted to the Contract Administrator 14 Days prior to construction, for information purposes only:

a) The type, source, and physical and chemical properties of the bentonite or polymer.

b) The source of water.

c) Method of mixing slurry.

d) The water solids ratio and the mass and volumes of the constituent parts, including any chemical admixtures or physical treatment employed to produce slurry with the required physical properties.

e) Details of procedure to be used for monitoring the quality of the slurry.

f) A test report showing the properties of the slurry and certifying that the slurry meets the requirements of API RP 13B-1.

g) Method of disposal of the slurry.

903.04.02.04 Installation

903.04.02.04.01 Driven Piles

The following shall be submitted to the Contract Administrator as least 14 Days prior to construction, for information purposes only:

a) A schedule of work identifying time and sequence of activities.

b) Type of equipment, anvil, helmet, and hammer details, including the hammer energy assumed by the Contractor, stated potential energy (rated energy) of the hammer, operating efficiency, and weight of ram.

c) Working Drawings of precast concrete piles showing the pile dimensions, concrete strength, tendon arrangement, working stresses and arrangement of steel reinforcement, schedules, elongation calculations, method and sequence of casting, complete specifications and details of the prestressing steel, and lift anchors and lifting point locations.

d) The method of maintaining the steel reinforcement cages in position, when steel reinforcement cages are used in tube piles.

e) Procedure for monitoring pile installation.

f) Details of the method of attaching proprietary driving shoes.

g) When load testing is specified in the Contract Documents, details of the full-scale test, including site preparation and the details of the load application, components, equipment, testing apparatus, and method of monitoring.

h) Information pertinent to establishing the resistance of a pile when the wave equation analysis method is used.

903.04.02.04.02 Caisson Piles

The following shall be submitted to the Contract Administrator at least 14 Days prior to construction, for information purposes only:

a) A schedule of work identifying time and sequence of activities.

b) Detailed procedures for caisson excavation in overburden and rock.

c) Detailed procedures for casing and liner installation and for the withdrawal of the liner.

d) Detailed procedures for slurry displacement method of excavation, including disposal of slurry upon completion.

e) Detailed procedures for tremie concrete, including the size of tremie delivery pipe.

f) Detailed procedure for placing concrete in the dry.

g) Method of maintaining the steel reinforcement cages in position in the caisson.

h) Details of filling the annular void around a casing.

i) Details of procedure to be used for monitoring installation.

j) When load testing is specified in the Contract Documents, details of the full-scale test, including site preparation, details of the load application, components, equipment, testing apparatus, and method of monitoring.

903.04.02.04.02.01 Milestone Inspections

Milestone inspections shall be performed by the Contract Administrator for the following interim inspections of the work for caisson piles:

a) Excavation.

b) Steel reinforcement installation.

c) Placing of concrete.

Written permission to proceed shall be received from the Contract Administrator prior to commencement of the next operation.

903.04.02.04.03 Displacement Caisson Piles

The following shall be submitted to the Contract Administrator as least 14 Days prior to construction, for information purposes only:

a) A schedule of work identifying time and sequence of activities.

b) Type of equipment, anvil, helmet, and hammer details, including the hammer energy assumed by the Contractor, stated potential energy (rated energy) of the hammer, operating efficiency, maximum stroke or drop, and weight of the ram.

c) Details of procedures used for installation of displacement caisson piles, including detailed procedures for liner installation and withdrawal.

d) Method of maintaining the steel reinforcement cages in position in the pile.

e) Details of procedure to be used for monitoring pile installation.

f) When load testing is specified in the Contract Documents, details of the full-scale test, including site preparation, and the details of the load application, components, equipment, testing apparatus, and method of monitoring.

903.04.02.04.04 Steel Reinforcement Cages

Working Drawings showing the fabrication details of the steel reinforcement cages, including the lifting points and lifting lugs, shall be submitted to the Contract Administrator at least 14 days prior to fabrication, for information purposes only.

903.04.02.05 Review of Splice Test Results and Permission to Proceed

Upon completion of the testing of the splices, the Contract Administrator shall review all test results to verify that all welds were done according to the welding procedures and Contract Documents and issue the Contractor written permission to proceed with the work.

903.05 MATERIALS

903.05.01 Wooden Piles

Wooden piles shall be according to CSA O56 and shall be clean and peeled. Treated piles shall be pressure treated with creosote according to CSA O80

Wooden piles shall be provided with collars sufficiently strong to prevent splitting of the head of the wooden pile during driving.

903.05.02 Steel Piles

903.05.02.01 H-Piles

Steel H-piles shall be according to CSA G40.20/G40.21, Grade 350 W.

903.05.02.02 Tube Piles

Steel tube piles shall be according to ASTM A252, minimum Grade 2.

903.05.02.03 Sheet Piles

Steel sheet piles shall be according to ASTM A328M.

903.05.02.04 Straightness Tolerance for Steel Piles, Casings, and Liners

Steel piles, casings, and liners shall conform to a straightness tolerance of 1.5 mm maximum per metre of length.

Steel sheet piles shall be sufficiently straight to prevent binding in the interlock during driving.

903.05.03 Driving Shoes and Rock Points

Rock points and driving shoes shall be as specified in the Contract Documents.

Driving shoes shall transfer the driving stresses to the pile over the full cross-sectional area of the pile.

Where precast concrete piles are driven into dense or hard material, a steel driving shoe cast into the concrete shall be provided.

Where wooden piles are driven into dense material, a steel plate driving shoe shall be provided to prevent damage to the bottom of the pile.

903.05.04 Casing for Caissons

Casings shall be according to ASTM A252, Grade 2. If welded, they shall be welded by the electric arc method according to CSA W59.

The casing wall thickness specified is the minimum that shall be supplied. The wall thickness shall be increased as required to ensure the casing is not damaged during handling and installation.

903.05.05 Steel Reinforcement

Steel reinforcement shall be according to OPSS 1440.

903.05.06 Concrete

903.05.06.01 General

Concrete shall be according to OPSS 1350.

903.05.06.02 Tube Piles

Concrete shall have a slump of 150 to 180 mm.

903.05.06.03 Caisson Piles

Concrete shall have a slump of 150 to 180 mm. Admixtures may be used to prevent arching of concrete during liner withdrawal and to prevent setting of concrete until after the liner is withdrawn.

903.05.07 Precast Concrete Piles

The production of precast reinforced concrete piles shall be according to OPSS 904, OPSS 905, and OPSS 909.

Steel reinforcement shall be placed such that direct loading during the ram stroke shall not occur.

Lifting anchors shall be at least 25 mm clear from reinforcement or prestressing steel in the pile.

Concrete in precast reinforced concrete piles shall be according to OPSS 1350 and have a nominal minimum 28-Day compressive strength of 45 MPa.

Concrete for precast reinforced concrete piles shall be cured according to OPSS 904.

Concrete for precast reinforced concrete piles shall be placed in smooth mortar-tight forms that are supported to prevent excessive deformation or settlement during placing or curing.

Unformed surfaces shall be finished smooth.

When removed from the form, the pile shall present true, smooth, even surfaces free from honeycombs and voids. The pile shall be straight so that a line stretched from butt to tip on any face shall not be more than 25 mm from the face of the pile at any point.

Each precast reinforced concrete pile shall have the date of manufacture (i.e., yyyy-mm-dd) inscribed on it.

903.05.08 Slurry

903.05.08.01 Solids

Bentonite and polymers shall be according to API Spec 13A.

903.05.08.02 Water

Water shall be according to OPSS 1302.

903.05.08.03 Slurry Composition

The slurry shall consist of a stable colloidal suspension of pulverized solids or polymers thoroughly mixed with water. The density, viscosity, sand content, and pH of the slurry being used during excavation shall be according to API RP 13B-1.

903.06 EQUIPMENT

903.06.01 Hammers

Hammers shall be capable of installing the piles, casings, and liners to the depth or resistance specified in the Contract Documents, without damage to the portions that are not cut off.

The hammer used to chisel the rock point into the rock shall be capable of delivering a controlled blow in 10% increments ranging in energy from zero to the maximum hammer energy.

For precast reinforced concrete piles, the heaviest hammer practicable shall be employed and the stroke limited so as not to damage the piles. When choosing the size of the hammer, consideration shall be given to whether the pile is to be driven to a resistance or to a given depth.

903.06.02 Helmets and Striker Plates

The head of steel piles shall be protected by a striker plate or a helmet. Helmets shall have adequate and suitable cushioning material. Helmets and striker plates shall distribute the blow of the hammer evenly throughout the cross-section of the pile head.

903.06.03 Leads

Pile driver leads shall be built to afford freedom of movement for the hammer and shall be held in position at the top and bottom by guys, stiff braces, or other approved means to ensure support of the pile, casing, or liner while it is being driven. Swinging leads shall not be permitted.

Batter piles, casings, or liners shall be driven with leads aligned parallel to the axis of the pile, casing, or liner. The leads shall be equipped with a fixed, rigid, adjustable kicker.

903.06.04 Followers

When use of followers are specified in the Contract Documents, followers shall be of type, size, shape, length, and weight as to permit driving the pile, casing, or liner at the location and to the required depth or ultimate resistance specified in the Contract Documents. The follower shall be provided with a socket or hood carefully fitted to the top of the pile, casing, or liner to minimize loss of energy and to prevent damage to the pile, casing, or liner, and shall have sufficient rigidity to prevent "whip" during driving.

When followers are permitted, an identical follower shall be used when the set is being determined.

903.07 CONSTRUCTION

903.07.01 Transporting, Storing, and Handling Piles, Casings, Liners, and Reinforcing Steel Reinforcement Cages

903.07.01.01 General

Piles, casings, liners, and steel reinforcement shall be transported, stored, and handled in such a manner that damage is prevented and the strength of the components is not affected by deterioration or deformation. Components shall be lifted and placed using appropriate lifting equipment, temporary bracing, guys, or

stiffening devices so that the components are at no time overloaded, unstable, or unsafe.

Material shall be supported to prevent unequal settlement when stacked.

903.07.01.02 Wooden Piles

Canthooks, dogs, pile pulls, or use of other lifting methods that might damage the integrity of the pressure treated surface shall not be used. Cuts or breaks in the surface of treated piling shall be given three brush coats of hot creosote oil. Bolt holes shall be treated with three applications of hot creosote oil applied with a bolt hole treater.

903.07.01.03 Handling Holes in Steel Piles

Unless otherwise approved by the Contract Administrator, holes shall only be made in the portion of the pile to be cut off or in the portion of the pile to be encased in concrete.

When other holes are approved to be cut in a pile they shall be covered by splice plates placed on both sides of the section. The thickness and the mechanical properties of the plate material shall be at least equivalent to the pile material.

903.07.01.04 Precast Reinforced Concrete Piles

Precast concrete piles shall be handled only from the designated lifting points.

When lifting or transporting precast reinforced concrete piles lift anchors, slings, or other approved means shall be used. Care shall be taken when lifting and transporting to avoid any overstressing of the pile or cracking of the concrete.

Precast reinforced concrete piles shall be so handled to avoid breaking or chipping their edges.

Lift anchors shall be removed and the holes filled with a non-shrink grout or epoxy installed according to the manufacturer's recommendations.

903.07.01.05 Caisson Casings and Liners

Casings and liners shall be handled and stored in such a manner to avoid damage or distortion to them. The casings and liners shall be maintained circular within $\pm$ 2% of the casing or liner diameter.

903.07.02 Driven Piles

903.07.02.01 Pile Driving Requirements and Restrictions

Piles shall not be driven until embankment work or excavation work has been completed to the underside of the footing. When driving of the piles is completed, all material between the piles shall be removed to the correct elevation and any holes or voids created shall be filled to the correct elevation with compacted material approved by the Contract Administrator.

Piles shall be installed at the locations specified in the Contract Documents and to the set or depth specified without being damaged. Damage to the pile, casing, or liner during driving shall be prevented by limiting the drop or energy and number of blows of the hammer. The hammer, helmet, cap block, striker plate, and pile shall be coaxial and shall sit squarely upon each other.

A shorter stroke shall be used and proper precaution shall be taken when there is a danger of damaging or over driving the piles, casing, or liners under conditions such as:

a) In the early stages of driving a long pile where a hard layer near the ground surface has to be penetrated.

b) Where there is very soft material of a considerable depth and a large penetration is achieved at each hammer blow.

c) Where it is anticipated the pile shall meet refusal on rock or other impenetrable soil.

d) When piles are driven onto sloping bedrock.

Damage to adjacent structures, Utilities, and fresh concrete shall be prevented during pile installation. Piles shall not be driven within a radius of 8 m of concrete that has been in place for less than 72 hours. Piles shall not be driven within a radius of 15 m of concrete that has been in place for less than 72 hours without the approval of the Contract Administrator.

The tops of all piles shall be either square to the longitudinal axis of the pile or horizontal as indicated in the Contract Documents.

Piles shall not be forced into their proper position by the use of excessive manipulation. Pile damage due to excessive driving shall be avoided.

903.07.02.02 Driving Shoes and Rock Points

Driving shoes and rock points shall be installed in locations specified in the Contract Documents.

Driving shoes shall be welded in accordance with the Contract Documents.

When driving shoes are specified in the Contract Documents, the Titus H bearing pile point, standard model, may be substituted for the driving shoes.

When Oslo points are specified in the Contract Documents, the Titus H bearing pile point, rock injector model, may be substituted for the pile points.

Where proprietary driving shoes are used, they shall be welded or otherwise attached to the driven piles according to the manufacturer's specifications.

903.07.02.03 Splicing

903.07.02.03.01 General

Any damaged material shall be cut-off prior to splicing.

903.07.02.03.02 Wooden Piles

Wooden piles shall not be spliced.

903.07.02.03.03 H-Piles, Tube Piles, and Sheet Piles

Welding shall be according to CSA W59 and shall be done by a qualified welder employed by a firm certified according to CSA W47.1, Division 1 or Division 2.1.

Steel H-piles and steel tube piles may be spliced providing that the pieces being spliced are not less than 3 m long, except for piles at integral abutments, the pieces being spliced shall not be less than 7 m long. Splices in piles located into a watercourse shall only be introduced under the low water level, unless the piles are encased in concrete.

Sheet piles shall not be spliced without approval by the Contract Administrator.

903.07.02.03.04 Precast Reinforced Concrete Piles

Precast reinforced concrete piles shall only be spliced when specified in the Contract Documents and the splices shall only be made with approved mechanical splicing devices.

903.07.02.04 Concrete in Steel Tube Piles

Concrete in steel tube piles shall be placed according to OPSS 904.

903.07.02.05 Cutting Off Piles

903.07.02.05.01 General

Driven piles shall be cut to the elevation as specified in the Contract Documents.

The length of pile supplied shall be sufficient to ensure there is no damaged material below the cut off. Damaged material at the pile head shall be cut off.

Piles shall not be cut off until retapping, redriving, and specified load testing are complete.

903.07.02.05.02 Wooden Piles

Where wooden piles are broomed, splintered, or otherwise damaged below the cut-off elevation, the pile shall be considered defective and shall be replaced.

903.07.02.06 Protective Coating for Steel H and Steel Tube Piles

Exposed steel H and steel tube piles shall have a coal tar epoxy protective coating applied from an elevation 600 mm below the low water level or finished ground surface up to the top of the exposed steel.

The steel surfaces shall be cleaned according to SSPC-SP10 prior to application of a coal tar epoxy system that shall be according to OPSS 911.

903.07.02.07 Monitoring Driven Piles

903.07.02.07.01 General

The driving of piles shall be carefully monitored and controlled and pile driving records produced for each pile.

903.07.02.07.02 Driving to a Specified Elevation

Piles shall be driven to an elevation specified in the Contract Documents. Driving piles to other elevations shall only be done when approved in writing by the Contract Administrator.

903.07.02.07.03 Driving to a Specified Ultimate Resistance

903.07.02.07.03.01 General

The Contract Administrator shall establish the reference set used to determine ultimate resistance and measure and record the set for individual pile acceptance.

The set and rebound measurements shall be obtained by the Contract Administrator. The Contract Administrator shall determine the measured ultimate resistance and verify that the design ultimate resistance has been achieved.

903.07.02.07.03.02 Driving to a Set

The founding elevation shall be established by driving to a set determined in accordance with the dynamic formula specified in the Contract Documents or by the application of the wave equation analysis procedure that verifies the pile resistance. This set shall be established on the first pile of every ten piles driven in a pile group.

The other piles shall be controlled by the pile penetration rate in blows per millimetre that correlates to the set.

When new conditions, such as change in hammer size, change in pile size, or change in soil material occur, new sets shall be determined.

903.07.02.07.03.03 Driving to Bedrock

When driving piles to bedrock, the pile shall be adequately seated on bedrock without damaging the pile.

Where rock points are used, the rock points shall penetrate into the rock. Piles driven using rock points shall be driven to ensure adequate seating on the bedrock without damaging the pile.

Driving of piles on sloping bedrock shall be stopped when initial contact is made with the bedrock. The bedrock elevation shall be recorded. Driving shall then continue, commencing with energy of 10% of the maximum energy of the hammer. The pile shall be driven in sets of 20 blows at this energy until no penetration is observed. Twenty additional blows shall be applied, and, if no penetration is observed, the energy shall be increased by an additional 10% and the above procedure repeated.

Driving shall continue with these stepped increases in energy and with the same series of blows as described above, until the pile has been seated on the bedrock.

If unrealistic excessive penetration per blow is observed, driving shall be stopped and this excessive penetration immediately reported to the Contract Administrator.

The Contract Administrator shall determine when the hammer energy can be increased and when the driving is complete for each pile.

903.07.02.07.04 Wave Equation Analysis

When requested by the Contract Administrator, all equipment, material, and personnel shall be supplied to conduct the wave equation analysis procedure. The Contract Administrator shall review the results of the analysis.

903.07.02.07.05 Hammer Performance

When requested by the Contract Administrator, the hammer performance using the pile driving analyzer or other approved equivalent shall be verified in the presence of the Contract Administrator. Hammer performance shall be verified to ensure that the actual potential energy (rated energy) is not less than 90% of the stated potential energy. All instrumentation, access, and assistance for the testing and monitoring as directed by the Contract Administrator shall be provided.

903.07.02.07.06 Retapping Tests on Piles

In each pile group, 10% of the piles rounded up to the next whole number, but no fewer than two piles, shall be retapped no sooner than 24 hours after installation of the individual pile to confirm that the ultimate axial resistance has been sustained.

Retapping of piles driven to bedrock is not required.

903.07.02.07.07 Retapping and Redriving Piles

When the retapping tests indicate that the ultimate axial resistance has not been achieved on any one pile, all piles in the group shall be retapped.

Where the retapping reveals that the ultimate axial resistance of the piles has not been achieved, the piles that have not achieved the ultimate axial resistance shall be redriven to the specified resistance.

Where piles have risen, the piles shall be redriven to the original depth.

903.07.02.08 Jetting

Jetting shall be carried out in such a manner that the resistance of the piles already in place and the safety of adjacent structures shall not be impaired. Jetting shall be stopped at least 1 m above the final expected pile-tip elevation and at least 1 m above the tip elevation of any piles previously driven within 2 m of the jet. Where piles are to be end bearing on rock, jetting may be carried to the rock surface.

The driving and jetting of precast reinforced concrete piles shall not be carried out simultaneously.

903.07.03 Caisson Piles

903.07.03.01 General

Caissons shall be constructed as specified in the Contract Documents.

The final bearing elevation shall be as specified in the Contract Documents or as determined by the Contract Administrator. When permanent casings are not specified, the caisson shall be constructed in a drilled hole with or without the use of a temporary liner or slurry as determined by the Contractor.

903.07.03.02 Excavation

903.07.03.02.01 General

Sidewall stability shall be maintained throughout the excavation and concrete placement operation. Soil cave-in into the excavation hole shall be prevented.

The bottom of the excavation shall be cleaned before the start of concrete placement.

Excavation methods shall be such that the sides and bottom of the hole are straight and free of loose material that might prevent intimate contact of the concrete with undisturbed soil or bedrock.

Except when founded on sloping rock, the caisson bottom shall be level. On sloping rock, the caisson bottom may be stepped, with each step not greater than ¼ the diameter of the bearing area.

903.07.03.02.02 Casings

When an auger is used to excavate for a casing, the diameter of the auger shall be no greater than the outside diameter of the casing.

903.07.03.02.03 Liners

The diameter of the excavation for the installation of liners shall not exceed the diameter of the liner by more than 150 mm.

903.07.03.02.04 Slurry Method

The level of slurry in the excavation shall be sufficient to prevent the intrusion of water and to maintain a stable wall with no cave-in, sloughing, or basal heave.

Slurry shall be tested as specified in API RP 13B-1All test equipment required for the tests shall be provided. A slurry sampler capable of obtaining samples at any depth within the caisson hole shall be available at all times.

At least 1 set of tests shall be completed every 4 hours during the slurry operation. Samples shall be taken from the mud tank and from within the caisson at a depth within 300 mm of the bottom.

903.07.03.03 Inspection of the Excavation

The bottom of excavations shall be visually inspected.

903.07.03.04 Dewatering

Where dewatering is required, a dewatering scheme shall be employed in such a manner as to prevent any disturbance to the base founding material. The dewatering shall not create subsidence or cause ground loss that may adversely affect the work or adjacent structures.

903.07.03.05 Backfilling Liners Left in Place

The annular space between a liner permanently left in place and shaft excavation shall be filled with concrete or fluid grout.

903.07.03.06 Steel Reinforcement

Steel reinforcement steel shall be installed according to OPSS 905. Steel reinforcement cages shall be checked to ensure conformance to the Working Drawings prior to installation and during placement of concrete.

The steel reinforcement cage shall be fabricated in one piece.

Welding of steel reinforcement and use of splices shall not be done unless specified in the Contract Documents.

The steel reinforcement shall not be displaced or distorted during the construction of the caisson.

903.07.03.07 Concrete

903.07.03.07.01 General

Concrete shall be placed in the caisson according to OPSS 904 and as specified herein. Concrete shall be placed immediately following interim inspection of the caisson hole by the Contract Administrator.

The reinforcement shall not be displaced or distorted during the construction of the caisson.

Arching of concrete during casing withdrawal shall be prevented.

903.07.03.07.02 Concrete Placed in the Dry

The concrete may be placed free fall provided the fall is vertically down the centre of the opening and transverse ties, spacers or other objects do not impede the free fall. In the event of interference with the concrete free fall, an elephant trunk or other means shall be used to prevent concrete segregation.

Concrete shall be placed in a continuous operation from the bottom to the top of the caisson or, where columns are cast integral with the caisson, to the elevation of the bottom of the column steel reinforcement cage. The concrete shall be vibrated for the last 1.5 m of the pour.

903.07.03.07.03 Concrete Placed Under Water or Under Slurry

Tremie or pumped concrete shall be carried out in one continuous operation. The tremie or pumping operation shall be a continuous flow of concrete that prevents the inflow of water or slurry.

Where tremie concrete is to be placed in a caisson under water, the Contractor shall maintain an adequate head of water within the excavations to prevent the inflow of water through the base or walls of the caisson as the concrete is being placed.

Where tremie is placed under slurry, the caisson shall be filled with concrete entirely by tremie and the method of deposition shall not be changed part way up the caisson.

When concrete placement is not started within 6 hours of acceptance of the excavation, the excavation shall be redrilled, cleaned, and the slurry tested before concrete placement commences.

903.07.03.07.04 Withdrawal of Liners

Arching of concrete during withdrawal of the liner shall be prevented.

During withdrawal, the bottom of the liner shall have a minimum embedment into the concrete being placed and a sufficient head of concrete shall be maintained above the bottom of the liner at all times to prevent intrusion of soil and water into the hole.

During withdrawal, upward or downward movement of the steel reinforcement shall be monitored. Upward or downward movement shall be restricted to 150 mm.

A theoretical concrete level shall be calculated based on the quantity of concrete placed and the caisson dimensions, and this theoretical level shall be compared to the actual level of concrete in the caisson to provide a check for possible separation of shaft concrete during liner withdrawal.

903.07.03.07.05 Founding Elevation

The final founding elevation shall be as specified in the Contract Documents or an elevation approved in writing by the Contract Administrator. When casings are not specified in the Contract Documents, the caisson shall be constructed in a drilled hole with or without the use of a liner or slurry as determined by the Contractor.

Except when founded on sloping unweathered bedrock, the caisson bottom shall be level. On sloping unweathered bedrock, the caisson bottom may be stepped, with each step not greater than one quarter the diameter of bearing area.

The bearing area of the caisson pile shall be approved by the Contract Administrator prior to placing concrete.

903.07.04 Displacement Caisson Piles

Work shall be carried out in accordance with the displacement caisson pile suppliers' installation procedures. A permanent liner shall be used when specified in the Contract Documents.

The sequence of installation shall be such as to prevent damage to any recently completed piles.

The pile shall not be founded above or below the specified pile tip elevation without approval in writing from the Contract Administrator.

903.07.05 Tolerances

903.07.05.01 Driven Piles

a) Cut-off elevation ± 25 mm.

b) Deviation from vertical not more than 1H:50V, except in the case of a pile cap or footing supporting only a single row of piles the deviation shall not be more than 1H:75V in the direction of the span.

c) The deviation from the specified inclination for battered piles shall not exceed 1H:25V.

d) The centre of the pile at the junction with the pile cap shall be within 150 mm measured horizontally of that specified except in the case of a pile cap or footing supported on a single row of piles the deviation shall not be more than 75 mm measured horizontally in the direction of the span.

903.07.05.02 Caissons and Displacement Caisson Piles

a) Cut-off elevation ± 25 mm.

b) Horizontal location at cut-off not more than 5% of shaft diameter or 75 mm, whichever is less.

c) Vertical alignment not more than 2% of the caisson length from vertical for vertical caissons, or 2% of the caisson length from the specified inclination for battered caissons.

903.07.06 Load Test

When a load test is specified in the Contract Documents, the testing shall be according to ASTM D1143M for piles under vertical static load, ASTM D3689 for piles under tensile load, and ASTM D3966 for piles under lateral loads. All records and results of the pile load test shall be submitted to the Contract Administrator.

All necessary personnel, equipment, and material to make adjustments during the tests shall be provided and at least one skilled worker shall be present for the complete duration of each test. This worker shall have demonstrated experience in load testing of piles.

The following shall be provided for the duration of all testing:

a) A level dry working area at the test location

b) An adequate enclosure sufficient to provide complete protection from adverse weather conditions

c) All temporary work required to obtain access to the site for the personnel, equipment, and materials.

Upon completion of the tests, the site shall be cleared and restored to the satisfaction of the Contract Administrator. Piles that are not part of the finished work shall be cut off 1.2 m below ground level or 0.6 m below stream bed level. Any resulting void shall be backfilled with suitable fill material.

903.07.07 Repair of Welds

Any section of weld that does not meet the requirements of the Contract Documents shall be removed and rewelded.

903.08 Quality Assurance

903.08.01 Inspection and Testing of Welds

903.08.01.01 Qualifications of Companies and Individuals

The Contract Administrator shall have an independent testing company carry out the non-destructive testing of welds. The independent testing company shall be certified by the Canadian Welding Bureau to the requirements of CSA W178.1 for bridge structures by radiographic or ultrasonic test methods.

Testing shall be done by a non-destructive testing technician employed by the independent testing company. The non-destructive testing technician shall have documented evidence of training and professional knowledge, skill, and experience in non-destructive testing of structural steel welds and material and have a valid certificate showing qualification to a Level II or III according to CGSB 48.9712 and the Canadian Welding Bureau for the non-destructive testing specified.

A welding inspector, employed by an independent testing company, shall perform visual inspection. The welding inspector shall have documented evidence of training, professional knowledge, skill and experience in visual inspection of structural steel welds and material, and have a valid certificate showing qualification to a Level II or III according to CSA W178.2.

903.08.01.02 Visual Inspection of Welds

A representative sample of not less than 30% of the welds, as determined by the Contract Administrator, shall be visually inspected for conformance to the requirements of CSA W59, the Contract Documents, and the Working Drawings.

903.08.01.03 Non-Destructive Testing of Welds

The non-destructive testing technician shall carry out radiographic or ultrasonic testing using procedures according to CSA W59.

Ultrasonic or radiographic testing shall be carried out on the entire length of selected splice welds chosen at random by the Contract Administrator or the welding inspector assigned to carry out visual inspection. Selection shall be based on the following criteria:

a) For pile groups other than at integral abutments, 10% of the splice welds, rounded to the next highest number, but no fewer than two.

b) For pile groups at integral abutments, 10% of the splice welds, rounded to the next highest number, but no fewer than two of when the welds are below 6 m of the pile cut-off elevation.

c) For pile groups at integral abutments, all splice welds within 6 m of the pile cut-off elevation.

903.08.01.04 Repaired Welds

All welds that have been repaired shall be visually inspected and shall undergo non-destructive testing.

903.08.02 Visual Inspection Reports and Non-Destructive Test Reports

Within 7 Days of completion of the inspection and testing, the welding inspection company shall submit 2 copies of all inspection and testing reports to the Contract Administrator, for information purposes only.

903.09 MEASUREMENT FOR PAYMENT

903.09.01 Actual Measurement

903.09.01.01 H-Piles, Tube Piles, Wooden Piles, and Precast Reinforced Concrete Piles

Measurement of piles shall be by length in metres of the piling left in place after cut-off.

903.09.01.02 Sheet Piles

Measurement of sheet piles shall be by area in square metres based on the driving lines specified and the length of piling left in place after cut-off.

903.09.01.03 Driving Shoes

For measurement purposes, a count shall be made of the number of drive shoes used.

903.09.01.04 Rock Points

For measurement purposes, a count shall be made of the number of rock points used.

903.09.01.05 Caissons and Displacement Caisson Piles

Measurement of caissons and displacement caisson piles shall be by length in metres of the depth along the centreline between the approved bearing surface at the bottom and the specified elevation at the top.

903.09.01.06 Retapping Piles

For measurement purposes, a count shall made of the number of piles retapped above and beyond the minimum number described in the Retapping Tests on Piles clause.

Piles retapped as part of the minimum number required for the retapping tests described in the Retapping Tests on Piles clause shall not be measured for payment.

903.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

903.10 BASIS FOR PAYMENT

903.10.01 Supply Equipment for Installing Driven Piles - Item
Supply Equipment for Installing Caisson Piles - Item
Supply Equipment for Installing Displacement Caisson Piles - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material required to do the work.

For payment purposes, 50% of the work under this item is completed when the satisfactory performance of the equipment has been demonstrated to the Contract Administrator by the installation of 1% of piles. The remaining 50% shall be paid on the satisfactory completion of the installation of piles.

When the hammer performance is requested to be verified, such verification shall be completed at no extra cost to the Owner when the energy delivered is less than 90% of the stated potential energy (rated energy) specified in the submission.

When the energy is equal to or greater than 90% of the stated potential energy stated in the required submission, the cost verifying the hammer performance shall be paid as Extra Work.

903.10.02 **H-Piles - Item**
Tube Piles - Item
Precast Concrete Piles - Item
Wood Piles - Item
Displacement Caisson Piles - Item
Caisson Piles - Item
Driving Shoes - Item
Rock Points - Item
Sheet Piles - Item
Load Test - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Payment for redriving piles shall be at the Contract price for the applicable tender item above.

When the Contractor substitutes driving shoes or Oslo points with Titus H bearing pile points, the cost of such substitutions shall be at no extra cost to the Owner.

903.10.03 **Retapping Piles - Item**

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

Retapping the minimum specified number of piles for retapping tests shall include all labour, Equipment, and Material to do the work and shall be included in the Contract price for the appropriate pile tender item.

Where additional retapping is required, payment shall be made based on the ratio of the number of piles retapped in a pile group above the minimum requirement, up to the total number of piles in that pile group, times the tender price for retapping all piles for that pile group.

Appendix 903-A, November 2020
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Load testing of driven piles. (903.04.02.04.01 g))
- Load testing of caisson piles. (903.04.02.04.02 j))
- Load testing of displacement caisson piles. (903.04.02.04.03 f))
- Welding. (903.04.02.06)
- Rock points and driving shoes. (903.05.03)
- Depth or resistance of piles, casings, and liners. (903.06.01)
- Type, size, shape, length, and weight of followers for piles, casings or liners. (903.06.04)
- Driven pile location and set or depth. (903.07.02.01)
- Driven pile cut off details. (903.07.02.01)
- Driven pile location and welding of driving shoes and location of rock points. (903.07.02.02)
- Splicing of precast reinforced concrete piles. (903.07.02.03.04)
- Cut off elevation of driven piles. (903.07.02.05.01)
- Driven pile elevation. (903.07.02.07.02)
- Dynamic formula for determining driving set for piles. (903.07.02.07.03.02)
- Caisson construction and elevation. (903.07.03.01)
- Steel reinforcement welding and splices. (903.07.03.06)
- Founding elevation of caisson piles. (903.07.03.07.05)
- Casing for caisson piles. (903.07.03.07.05)
- Displacement caisson pile permanent liner. (903.07.04)
- Load test for piles. (903.07.06)
- Visual inspection of welds. (903.07.08.01.02)

Appendix 903-A

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 3000.100	Foundation, Piles, Steel H-Pile, Driving Shoe
OPSD 3000.150	Foundation, Piles, Steel H-Pile, Splice
OPSD 3000.201	Foundation, Piles, Steel HP 310 Oslo Point
OPSD 3001.100	Foundation, Piles, Steel Tube Piles, Driving Shoe
OPSD 3001.150	Foundation, Piles, Steel Tube Piles, Splice
OPSD 3002.200	Foundation, Piles, Steel Sheet Piles, Anchorage
OPSD 3003.100	Foundation, Piles, Wood, Driving Shoe
OPSD 3003.150	Foundation, Piles, Wood, Pile Head Protection

CONSTRUCTION SPECIFICATION FOR CONCRETE STRUCTURES

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904-A **Commentary**

904.01 SCOPE

This specification covers the requirements for the construction of concrete structures.

904.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

904.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

904.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 501	Compacting
OPSS 905	Concrete Reinforcement
OPSS 908	Metal Traffic Barriers and Metal Railings for Structures
OPSS 919	Formwork and Falsework
OPSS 920	Deck Joint Assemblies, Waterstops, Joint Fillers, Joint Seals and Joint Sealing Compounds - Structures
OPSS 928	Structure Rehabilitation - Concrete Removal
OPSS 929	Abrasive Blast Cleaning - Concrete Construction
OPSS 930	Structure Rehabilitation - Concrete Patches and Overlays
OPSS 932	Crack Repair - Concrete

Ontario Provincial Standard Specifications, Material

OPSS 1002	Aggregates - Concrete
OPSS 1202	Bearings - Elastomeric Plain and Steel Laminated
OPSS 1301	Cementing Materials
OPSS 1302	Water
OPSS 1315	White Pigmented Curing Compounds for Concrete
OPSS 1350	Concrete - Materials and Production

Ontario Ministry of Transportation Publications

Laboratory Testing Manual:
LS-413 Method of Test for Non-Volatile Content of Chemical Admixtures, Latex Admixtures and Curing Compounds
LS-414 Method of Test for Relative Density of Chemical Admixtures, Air Entraining Admixtures, Latex Admixtures and Curing Compounds
LS-416 Method of Test for Settling Rate - Curing Compound

ASTM International

C 171-92 Sheet Materials for Curing Concrete

American Association of State Highway and Transportation Officials (AASHTO)

M182-89 Standard Specification for Burlap Cloth made from Jute or Kenaf

904.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Bridge means a structure that is greater than 3 m in span that provides a roadway, carriageway, or walkway for the passage of vehicles or pedestrians or both across an obstruction or gap or facility.

Coated Reinforcing Steel Bars means reinforcing steel bars coated with epoxy.

Cold Joint means the interface surface other than at a formed joint that occurs when plastic concrete is placed against concrete that has taken its initial set.

Cold Weather means those conditions when the ambient air temperature is at or below 5 °C. It is also considered to exist when the ambient air temperature is at or is likely to fall below 5 °C within 96 hours after completion of concrete placement. Temperature refers to shade temperature.

Concrete Toe Wall means a low unreinforced concrete gravity type retaining wall no greater than 2 m in height.

Construction Joint means the surface where two successive placements of concrete meet or where new concrete is placed against old concrete across which it is desirable to achieve bond between the two concrete placements and through which steel reinforcement may be continuous.

Culvert means a structure which provides an opening through an embankment and in which roadway loads are distributed to the structure through fill or that is designated as a culvert in the Contract Documents.

Designated Limits means the dimensions of the component as shown on the Contract Drawings or the limits of the component as revised in the field in writing by the Contract Administrator.

Dowel means deformed coated reinforcing steel bar, reinforcing steel bar or stainless steel reinforcing bar placed into a hole of specified dimensions drilled into a concrete structure and bonded to the concrete by dowel adhesive.

Dowel Type means a dowel differentiated by bar size, embedment length, orientation of embedment and by bar material, such as 15M stainless steel reinforcing bar and 20M reinforcing steel bar.

High Performance Concrete (HPC) means concrete with a minimum specified 28-Day compressive strength of at least 50 MPa, that shall include silica fume and may include other supplementary cementing materials having a specified rapid chloride permeability at 28-32 Days of 1,000 coulombs or less.

Honeycombing means rough and stony concrete surface with voids where the mortar did not fill the spaces between the coarse aggregate particles.

Pull Test means an in situ test consisting of the application of a specified tensile axial load for a specified time period to installed dowels selected for testing.

Reinforcing Steel Bars means plain or deformed steel bars, or welded wire fabric, with no epoxy coating, used for the reinforcement of concrete.

R Value means the metric thermal resistance value that is a measurement of the resistance to heat transfer of insulation.

Segregation means visible separation of the mortar and coarse aggregate particles in the plastic concrete resulting in concrete that is not uniform in appearance or proportions.

Stainless Steel Reinforcing Bar means plain or deformed stainless steel bars.

Steel Reinforcement means a general term for steel bars, which includes reinforcing steel bars, splice bars, coated reinforcing steel bars, stainless steel reinforcing bars, and welded wire fabric.

Structure means any bridge, culvert, tunnel, retaining wall, wharf, dock, or guideway, or any part thereof, or other reinforced concrete component designed to carry loads, including high mast pole footings and sign support footings.

Tremie means a hopper with a vertical pipe extending from the bottom of the hopper to the lowest point of concrete deposit, used to place concrete under water.

904.04 DESIGN AND SUBMISSION REQUIREMENTS

904.04.01 Submission Requirements

904.04.01.01 Notification of Placement of Structural Concrete

At least 72 hours prior to each placing operation, the Contractor shall notify the Contract Administrator in writing of the scope and scheduling of the proposed placing operation.

904.04.01.02 Bridge Deck Placement Plan

A work plan shall be submitted to the Contract Administrator a minimum of one week prior to commencement of placing concrete in bridge decks for information purposes. The work plan shall include:

a) The proposed methods and sequence of placing operations to be used.

b) Complete details of all equipment to be used during the concrete placement.

904.04.01.03 Temperature Control Plans

A temperature control plan shall be submitted to the Contract Administrator a minimum of one week prior to commencement of placing any concrete that requires temperature control, for review of compliance with the contract requirements.

The plan shall include methods for monitoring and controlling concrete temperature and the temperature difference before, during, and after placement for:

a) Concrete subject to cold weather.

b) HPC.

c) Bridge decks.

d) Large concrete components where the smallest dimension is 1.5 m.

The temperature control plan shall include, as a minimum, the following:

a) Concrete element for which the plan applies.

b) Temperature monitoring system, including the locations and depths, number of thermocouples, and frequencies of recordings to be used in each placement.

c) Method of ensuring concrete temperature and temperature difference are maintained for the duration of the protection period.

d) Any alterations to work schedule, production, delivery schedule, and time of placement for temperature control purposes.

e) Any modification to mix design for temperature control purposes.

f) Any other specific measures to be taken.

g) Method of withdrawal of protection.

In addition, for concrete subject to cold weather, the temperature control plan shall also include the following:

a) Type of insulation, R value and number of layers, including test data verifying the R value. The submission for cold weather protective measures shall be accompanied by samples of insulation, if requested by the Contract Administrator.

b) Type and layout of heaters and type and extent of housing.

904.04.01.04 Temperature Records

Datalogger temperature records and a record of any actions taken to maintain control of temperature and temperature difference shall be forwarded to the Contract Administrator at the end of each working day during the temperature monitoring period. At the end of the temperature monitoring period, the Contractor shall submit to the Contract Administrator a complete temperature record, including graphical plot of temperature versus time.

904.04.01.05 Curing Compound

A minimum of one week prior to the application of the curing compound, the following shall be submitted to the Contract Administrator for information purposes:

a) Literature stating the manufacturer's recommended rate of application.

b) Description of the equipment to be used.

c) A statement from the manufacturer of the curing compound approving the equipment.

Test results for curing compounds shall be submitted to the Contract Administrator within 7 Days of sampling.

904.05 MATERIALS

904.05.01 Concrete

Concrete shall be according to OPSS 1350.

904.05.02 Portland Cement

Portland cement shall be according to OPSS 1301.

904.05.03 Sand

Sand shall be according to OPSS 1002.

904.05.04 Bonding Agents

Bonding agent shall consist of Portland cement, Type GU, and sand in the ratio of 1:1 by volume and water sufficient water to produce a consistency such that it can be applied with a stiff brush to the existing concrete in a thin even coating that shall not run or puddle.

904.05.05 Mortar

Mortar shall be a 2:1 mixture by volume of sand and Portland cement, Type GU, and shall contain 12% entrained air with water sufficient to make a stiff mix.

904.05.06 Proprietary Patching Materials

Proprietary patching materials shall be from the ministry’s list of concrete patching materials.

904.05.07 Burlap

The burlap shall be according to AASHTO M182, Class 4, and shall be free from substances that are deleterious to concrete. The burlap shall have no tears or holes.

904.05.08 Water

Water used for curing and fog misting of concrete, including pre-soaking of burlap, and for making bonding agents and mortar and mixing proprietary patching materials, shall be according to OPSS 1302.

904.05.09 Moisture Vapour Barrier

The material shall be a white opaque polyethylene film according to ASTM C 171, at least 100 µm thick.

904.05.10 Curing Compound

Curing compound shall be according to OPSS 1315.

904.05.11 Approach Slab Seat Elastomer

The elastomer delivered to the site shall exceed the required length to allow for a 600 mm test sample to be taken from each structure.

The elastomer shall be according to the plain bearing requirements of OPSS 1202, except that the hardness of the elastomer shall be a minimum of 50 Shore A, and the elastomer shall have a minimum tensile strength of 15 MPa.

904.05.12 Insulation Material

Insulation material shall be mineral wool, glass fibre, plastic foam or other suitable material, having an R value not less than 0.02 m^2 C/W per 1 mm thickness.

Straw insulation shall not be used. Loose or absorbent insulation material shall not be used unless it is completely contained within waterproof wrapping.

904.05.13 Dowels

Dowels shall be as specified in the Contract Documents. Dowels shall be capable of sustaining the pull test loads specified in Table 1 without displacement for a time period of not less than 1 minute.

904.05.14 Dowel Adhesive

Dowel adhesive shall be an approved epoxy or acrylic resin.

904.06 EQUIPMENT

904.06.01 General

Equipment made of aluminium material shall not come in contact with the plastic concrete.

904.06.02 Concrete Pump

The concrete pump shall be a reciprocating pump equipped to fit a pipeline at least 100 mm in diameter.

904.06.03 Consolidating Equipment

Internal vibrators shall be of the high frequency type with 8,000 minimum to 12,000 maximum vibrations per minute when immersed in concrete.

Internal vibrators used to consolidate concrete components containing epoxy coated steel reinforcement shall have a resilient covering that shall not damage the epoxy-coated reinforcement during use.

External vibrators shall have a minimum frequency of 3,600 vibrations per minute.

904.06.04 Mixer for Bonding Agents

The mixer for the bonding agent shall be a stationary mixer, power driven, and capable of uniformly mixing the materials.

904.06.05 Finishing Machine

The finishing machine shall:

a) Be self-propelled and capable of forward and reverse movement under positive control.

b) Be fitted with wheels that travel on adjustable screed rails.

c) Be fitted with a reversing rotating cylinder screed capable of finishing the concrete without subsequent hand finishing.

d) Be fitted with a reversing power screw auger.

e) Be capable of externally vibrating the surface of the concrete by means of a plate or roller.

f) Be fitted with a means to raise all screeds to clear the screeded surface and to accurately reposition them without adjusting the legs.

g) Have adjustable legs fitted with locking devices.

904.06.06 Screed Rails

The rails shall be made of metal and be straight to within 3 mm in a 3 m length. Screed rail chairs shall be adjustable in height, made of metal, and spaced at a maximum of 1.2 m and be placed under all rail joints. Maximum deflection of the screed rails under load shall be 2 mm in a 1.2 m length.

904.06.07 Work Bridges

Work bridges shall be provided to facilitate surface finishing of unscreeded areas, corrections to surface finish, concrete inspection, and placing of curing materials.

Work bridges shall ride on the screed rails and the top surface of a work bridge shall not be higher than 1.0 m above the finished surface.

904.06.08 Hand Finishing Tools

Floats shall be made of magnesium or wood. Magnesium bull floats shall be commercially made.

904.06.09 Straight Edges

Two straight edges commercially made of metal, one 3 m and one 500 mm long, shall be used.

904.06.10 Tremie

The tremie shall be equipped with a foot valve at the bottom of the pipe. The pipe shall have a 300 mm $\pm$ 50 mm inside diameter and shall be long enough to extend to the lowest point of concrete deposit.

904.06.11 Spray Equipment for Curing Compound

The curing compound shall be applied to the concrete surface by means of motorized spraying equipment approved by the manufacturer of the curing compound. The equipment shall include mechanical agitator.

904.06.12 Compressor - Air Blasting

The compressor for air blasting shall have a minimum capacity of 3.5 m^3/minute. The compressed air shall be free of oil or other contaminants.

904.07 CONSTRUCTION

904.07.01 Formwork and Falsework

Formwork and falsework shall be according to OPSS 919. Textile form liners shall not be used.

904.07.02 Steel Reinforcement, Mechanical Connectors, and Associated Hardware

Steel reinforcement, mechanical connectors, and associated hardware shall be according to OPSS 905.

Where the superstructure is continuous over a support, all of the deck steel reinforcement shall be placed in the entire deck before any concrete is placed. This requirement does not apply to the bottom slab of post-tensioned box voided decks.

904.07.03 Deck Joint Assemblies and Joint Material

Deck joint assemblies, joint fillers, joint seals, joint sealing compounds, and external waterstops shall be according to OPSS 920.

904.07.04 Preparation for Concrete Placement

904.07.04.01 General

All concrete surfaces against which new concrete is to be placed, including formed and sawcut surfaces, shall be clean, solid, and free from loose or unsound fragments, coatings, and any other foreign substances or debris and shall be sufficiently rough to ensure that a full bond is developed with the new concrete. The concrete surface shall be uniformly roughened to a surface profile of 5 mm $\pm$ 2 mm by means of methods such as scabbling, chipping, or bushhammering to expose the aggregates across the entire surface. Roughening is not required for the vertical faces of slope paving or for new concrete substrate with a roughened finish, imparted at the time of placement, meeting the profile requirement.

904.07.04.02 Abrasive Blast Cleaning

The following surfaces shall be abrasive blast cleaned according to OPSS 929:

a) All existing steel reinforcement that shall be incorporated into the rehabilitation of a concrete structure component.

b) All surfaces of existing structural steel against which new concrete shall be placed for the rehabilitation of a concrete structure component.

c) All new or existing concrete surfaces against which new concrete shall be placed.

904.07.04.03 Pre-wetting

All concrete surfaces to receive concrete shall be maintained in a wet condition for a period of 1 hour prior to placing any new concrete.

Immediately prior to wetting the concrete surface, all dust and loose material shall be removed from the prepared surface by using compressed air.

Prior to placing concrete, excess water shall be removed from the surface using compressed air.

904.07.04.04 Bonding Agent

A bonding agent shall be used for:

a) Vertical surfaces of concrete against which new concrete is to be placed.

b) Blockouts in concrete for installation and modification of deck joint assemblies.

c) Stressing tendon anchorage recesses.

A thin uniform coating of bonding agent shall be brushed onto the prepared surface immediately before placing fresh concrete. Bonding agents shall be mixed by means of a mixer. Any bonding agent not used within 30 minutes of mixing shall be discarded. Bonding agent that has dried shall be removed and replaced prior to placing concrete against it.

904.07.04.05 Element-Specific Preparation

For concrete in footings, when it is specified in the Contract that the concrete is to be placed against undisturbed soil or set in rock, any over-excavation shall be filled with concrete of the same strength as the footing concrete.

For parapet and barrier walls and curbs on structures, all anchorages shall be fastened in place accurately and securely before proceeding with concrete placement. The railing anchorage inserts shall be fastened in place according to OPSS 908.

For concrete in approach slabs, the approach slab seat elastomer, polystyrene, and joint filler shall be installed and the subgrade thoroughly wetted down prior to placing the concrete in the approach slab, including the adjacent sidewalk slab.

For concrete in slope paving, the slope face shall be shaped; excavation completed; granular A placed and compacted; and the crushed rock, moisture vapour barrier, wood strips, and joint filler shall be placed as required prior to placing the concrete. Sealant shall be installed as specified in the Contract Documents.

The granular A shall be compacted according to OPSS 501.

904.07.05 Dowels into Concrete

904.07.05.01 General

The Contractor shall carry out pull testing of dowels in the trial installations and during production. Pull test loads shall be according to Table 1. The Contractor shall notify the Contract Administrator in writing when the trial installation or a lot, as defined in the Lot Size clause, is ready for testing. The Contractor shall allow 3 Business Days for the Contract Administrator to witness the testing.

The Contractor shall provide documentation of equipment calibration to the Contract Administrator a minimum of 14 Days prior to any pull testing of the dowels.

904.07.05.02 Trial Installation

Prior to installing each dowel type specified in the Contract Documents, the Contractor shall carry out a trial installation of that dowel type at locations selected by the Contract Administrator.

Each trial installation shall consist of a set of three dowels. If the Contractor changes the installation procedure for a dowel type from that used in the associated trial installation, the Contractor shall repeat the trial installation prior to incorporating dowels installed using the changed installation procedure into the work.

Each of the three dowels in the set shall be capable of achieving the specified test load and times, without any movement of the dowels, for the trial installation to be considered acceptable.

If the trial installation is not acceptable, installation of that dowel type in the work shall not be permitted until the following have been carried out by the Contractor to the satisfaction of the Contract Administrator:

a) A written explanation for the failure has been submitted.

b) Corrective action to be taken has been identified.

c) The trial installation has been repeated with acceptable results.

If a dowel is not capable of achieving the test load and time due to failure of the surrounding concrete, the Contractor shall not be permitted to install any additional dowels of that type in the work until further advised by the Contract Administrator.

904.07.05.03 Installation

The Contractor shall drill holes to the required dimensions, clean holes, place dowel adhesive, and properly position the dowels as specified in the Contract Documents. Core drilling of the dowel holes shall not be permitted.

Steel reinforcement and other existing embedments shall not be cut or damaged by the drilling process. Prior to drilling holes, the Contractor shall locate existing steel reinforcement using a covermeter, Utility ducts, post tensioning hardware, and any unsound concrete in the vicinity of the dowel locations. If any of the above is encountered during drilling operations, the Contract Administrator shall be notified immediately.

The Contractor's operations shall not cause spalling, cracking, or other damage to the surrounding concrete. Concrete spalled or otherwise damaged by the Contractor's operations shall be repaired in a manner acceptable to the Contract Administrator.

The Contractor shall clean the holes using compressed air to remove all deleterious material, including dust and debris, and shall dry them prior to placing the dowel adhesive. Holes that are started but not completed shall be cleaned and filled with a proprietary patching material.

The handling and placement of the dowel adhesive shall conform to the manufacturer's written instructions. All excess dowel adhesive shall be struck-off flush with the concrete surface and removed from the surrounding concrete surface area.

Dowels shall be clean and free of deleterious material.

The Contractor shall maintain dowels in the proper position during the setting of the dowel adhesive and shall prevent the loss of dowel adhesive from the holes.

904.07.05.04 Pull Test

904.07.05.04.01 General

The Contractor shall not install formwork or attach anything to the dowels such as steel reinforcement and Utility ducts until the pull tests have been completed and the dowels are accepted into the work.

904.07.05.04.02 Lot Size

A lot shall consist of dowels of the same dowel type installed on a given day, in a single stage. Where a given day's production is less than 50 dowels, the day's work may be combined with the next day's production to form a single lot.

904.07.05.04.03 Pull Test Procedure

The Contractor shall conduct pull testing for the trial installation and each lot within 3 Business Days of installation. The Contract Administrator shall be present during the testing procedure. The Contract Administrator shall randomly select 5% of the dowels in each lot or 10 dowels, whichever is greater, for testing. The applicable pull test load shown in Table 1 must be sustained by the dowel, without displacement, for a time period of no less than one minute.

904.07.05.05 Replacement of Failed Dowels

All dowels failing the pull test requirement, including trial installation dowels, shall be replaced by the Contractor by installing a new dowel in an adjacent location approved by the Contract Administrator.

Dowels failing the pull test requirement, including trial installation dowels, shall be removed and the hole filled with proprietary patching material.

904.07.06 Placing of Concrete

904.07.06.01 General

The method of transporting, placing, and consolidating the concrete shall be such as to prevent segregation.

Concrete shall be deposited within 1.5 m of its final position. When concrete is to be dropped more than 1.5 m, fully enclosed vertical drop chutes extending to the point of deposit shall be used. Drop chutes are not required for placing concrete in steel tube piles of 0.6 m diameter or less. Concrete shall be placed at a steady rate, such that a monolithic concrete is obtained without the formation of cold joints.

When there is an interruption in placing concrete greater than 20 minutes, the surface of the concrete shall be covered with wet burlap. The Contractor shall notify the Contract Administrator immediately of any interruption resulting in a cold joint and shall submit a proposal for remedial action for approval.

904.07.06.02 Concrete Placing Restrictions

No concrete shall be placed until all curing material and, in cold weather, all cold weather protection material, have been delivered to the site.

Barrier and parapet walls on structures shall not be slipformed.

When concrete is to be placed on a surface that has a slope greater than 3%, the placing operation shall begin at the lower end of the slope and progress upwards.

All surfaces against which concrete are to be placed shall be free of standing water, except for tremie concrete. Fresh concrete shall be protected from contact with rain or snow.

The temperature of formwork, steel reinforcement or the material on which the concrete is to be placed shall not exceed 30 °C.

Debris shall be removed from the area where concrete is to be placed.

Ice and snow shall be removed from the area where concrete is to be placed. Deicing chemicals shall not be used. Concrete shall not be placed on or against frozen ground. Excavations prepared for concreting and any existing concrete, steel reinforcement, structural steel, forms, or other surfaces against which concrete shall be placed shall be at a minimum temperature of 5 °C for a period of 12 hours prior to commencement of placing concrete.

904.07.06.03 Concrete in Structure and in Deck

Concrete diaphragms shall be placed monolithically with the deck.

All bridge deck placements 3 m or wider shall be finished using a finishing machine and a work bridge. Where placements are longer than 40 m or wider than 10 m, a second work bridge shall be used. For deck placements narrower than 3 metres, the Contractor shall submit a proposal detailing a method of finishing to the Contract Administrator for approval. Small, localized areas may be hand finished subject to approval by the Contract Administrator.

Where the superstructure is continuous over a support, the screed rails shall be placed for the entire length of the structure before any concrete is placed.

A dry run shall be carried out to ensure that the specified camber, crown, slab thickness, and concrete cover are achieved. In those areas of the deck where a finishing machine will be used to finish the concrete, the dry run shall be carried out by means of the finishing machine fitted with an attachment suitable for checking the required cover, securely fastened to the finishing machine strike-off, with the strike-off set in its lowest position. This operation shall be repeated to cover the entire area to be concreted.

For HPC and silica fume overlay, at the time of the dry run the Contractor shall demonstrate that the performance of the fog misting equipment meets the specified requirements.

Screed rails and the supports for the screed rails shall not be removed until the concrete has hardened sufficiently to withstand the weight of workers and equipment used to remove them without marring the surface of the concrete. Any part of the screed rail supports that remain in the deck shall have 100 mm of concrete cover. Chairs used to support screed rails shall not be welded to structural steel but may be welded to shear connectors.

The holes in the deck resulting from removal of the screed rail supports shall be thoroughly cleaned of all deleterious material and abrasive blast cleaned immediately prior to filling with proprietary patching material. The work of cleaning and filling the holes shall be completed within 96 hours after the end of the deck curing period.

904.07.06.04 Tremie Concrete

Concrete shall be placed using a tremie or concrete pump. No air or water pockets shall be introduced into the tremie concrete by the placing equipment.

Pipe of a tremie or hose of a concrete pump shall be positioned vertical and shall be long enough to reach the lowest point of concrete deposit. A continuous flow of concrete at a minimum rate of 15 m^3/h shall be maintained through the pipe or hose. The concrete shall be placed in its final position and to its full depth in a continuous placing operation without interruption. The top under water surface of the concrete shall be kept level during concrete placement. After placement, the concrete shall not be disturbed, puddled, or vibrated. Tremies or concrete pumps shall be located a maximum distance of 5 m apart and a maximum of 2.5 m from forms.

Concrete shall only be placed in water that has a temperature 2 °C or greater. The velocity of water flow inside the forms shall not be more than 3 m/min.

When placing the tremie pipe or concrete pump hose and at the start of the concreting operation, the pipe or hose shall be sealed at the bottom to prevent ingress of water. Once concrete is flowing through the pipe or hose, the discharge end shall be kept continuously immersed in the freshly placed concrete. If the seal is lost, thereby allowing the pipe or hose to fill with water, the pipe or hose shall be withdrawn, the seal re-established, and the starting operation repeated. Separate cranes shall be used to deliver the tremie concrete and to move and position the tremie or concrete pump.

Tremie concrete shall not be placed above the existing water level.

When a placement operation is interrupted below water level, the surface laitance shall be removed to expose the coarse aggregate within 36 hours after the interruption and before continuation of the operation.

When a placement operation is completed and work is to continue in the dry, the Contractor shall prepare the construction joint by removing surface laitance to expose the coarse aggregate.

Unwatering shall not be permitted until at least 24 hours after the concrete placement is completed.

904.07.07 On-Site Transportation

Runways for buggies shall be of sufficient strength to prevent shaking and jarring of the buggies and steel reinforcement.

Concrete placing and transporting devices shall not be supported by the steel reinforcement.

Chutes shall have sufficient slope to deliver concrete of the approved consistency and shall have a maximum length of 15 m.

904.07.08 Consolidation

Internal or external vibrators or both shall be used to thoroughly consolidate concrete at the point of deposit within 15 minutes of placing.

Each layer of concrete shall be vibrated. Vibrators shall extend into the previous layer to produce a homogenous mixture at the layer interface.

Vibration shall not be used to make the concrete flow or to spread the concrete more than 1.5 m from the point of deposit.

904.07.09 Concrete Finishing

Finishing of the concrete surface shall be done while it is sufficiently plastic to achieve the desired grades, elevations, and texture. The Contractor shall ensure that excessive fines and water are not drawn to the surface.

No material shall be applied to the concrete surface or the finishing tools to aid in the finishing.

The surface shall be smooth, free from open texturing, undulations, projections, and ridges and shall be struck off true to grade and cross-section and, except as specified for bridge deck placements, shall be hand finished with a float.

Bearing seats and expansion joint dams shall receive a wood float finish. The top surface of sidewalks and curbs shall be given a broomed finish. Bridge decks shall be finished according to the Concrete in Structure and in Deck clause. In addition, for bridge decks where the concrete forms the wearing surface, the surface shall be textured. Texturing shall be done with a wire broom or comb having a single row of tines after a tight, uniform surface has been achieved. The required texture shall be transverse grooves that may vary from 1.5 mm width at 15 mm centres to 4.5 mm width at 20 mm centres with a groove depth varying from 3.0 mm to 4.5 mm. The texture shall extend uniformly to within 150 to 300 mm of the curb. Concrete surfaces against which new concrete shall be placed shall be left with a rough surface finish.

904.07.10 Curing

904.07.10.01 General

The curing period shall be a minimum of 7 Days for concrete subject to cold weather, concrete cured with curing compound, and HPC. For all other concrete, the curing period shall be a minimum of 4 Days.

When the ambient air temperature is 0 °C or higher at the time of placing, components of structures shall be cured with burlap and water except as specified in the Curing Formed Surfaces clause. When the ambient air temperature is below 0 °C at the time of placing, components shall be cured with moisture vapour barrier, except for HPC, which shall be moist cured with burlap and water regardless of ambient air temperature. During cold weather, burlap shall be prevented from freezing.

Curing compound shall only be permitted for non-structural elements such as slope paving.

904.07.10.02 Fog Misting of High Performance Concrete

The Contractor shall provide fog misting by hand held fogging wands and may also employ a fogging system mounted on the finishing machine.

Fog mist shall be applied from the time HPC is deposited in the deck, approach slab, median, curb, or sidewalk until it is covered with burlap.

Fog mist shall be applied using misting nozzle in such a way as to maintain a fog mist above the concrete surface to maintain high relative humidity above the concrete and prevent drying of the concrete. No accumulation of water shall be permitted on the concrete surface. Water from fog misting nozzles shall not be worked into the concrete surface or used as a finishing aid.

904.07.10.03 Curing with Burlap and Water

Burlap shall be pre-soaked by immersing it in water for a period of at least 24 hours immediately prior to placing. Two layers of burlap shall be applied to the surface of the concrete. The burlap shall be applied immediately after finishing the concrete surface. For continuing operations, such as barrier wall or sidewalk, the burlap shall be applied within 2 to 4 m of the finishing operation, and for bridge decks, within 2 to 4 m of the pan or screed of the finishing machine. Burlap strips shall overlap 150 mm and shall be held in place without marring the surface of the concrete.

The burlap shall be maintained in a continuously wet condition throughout the curing period by means of a soaker hose. The burlap shall be covered with a layer of moisture vapour barrier, within 12 hours of placing of the concrete, in a manner that shall prevent deformation of the surface of the concrete.

Air flow in the space between the moisture vapour barrier and the burlap shall be prevented.

Water shall not be allowed to drip, flow, or puddle on the concrete surface when placing the burlap or at any time before the concrete has achieved final set.

Where waterproofing is to be applied to a structure deck following curing with burlap and water, the deck shall be air dried for at least 72 hours prior to the application of waterproofing.

904.07.10.04 Curing with Moisture Vapour Barrier

A moisture vapour barrier shall be placed immediately after finishing the concrete surface, within 2 to 4 m of the finishing operation. Air flow in the space between the moisture vapour barrier and the concrete surface shall be prevented. The moisture vapour barrier strips shall overlap 150 mm and shall be held in place at the edges and laps to prevent displacement, without marring the surface of the concrete.

904.07.10.05 Curing with Curing Compound

Immediately prior to application, the curing compound shall be agitated by mechanical means to provide a homogeneous mixture. It shall be applied immediately after finishing of the concrete surface, within 2 to 4 m of the finishing operation, completely covering the surface of the concrete. A second application of curing compound shall be applied within 30 to 60 minutes after the first application. Each application shall be such that the membrane formed is uniform in thickness and colour and free of breaks and pinholes.

The rate of each application shall not be less than the rate specified by the manufacturer of the compound.

904.07.10.05.01 Curing Compound Sampling and Testing

The Contractor shall be responsible for sampling and testing curing compounds. Curing compounds shall be sampled at the site, from the spray nozzle, in the presence of the Contract Administrator. Samples shall be taken at a frequency of one sample per contract or one sample per 1,000 lineal meters, whichever provides the greater number of samples. Testing shall be carried out by a laboratory on the ministry's list of laboratories qualified for this testing. Testing for relative density, non-volatile content, and settlement shall be carried out according to LS-413, LS-414, and LS-416.

904.07.10.06 Curing Formed Surfaces

Forms for structure barrier wall, parapet wall, and curb on deck shall be removed no later than 24 hours after concrete placement, and the concrete shall be cured according to the Curing with Burlap and Water clause for the remainder of the minimum curing period.

Other formed surfaces shall require no additional curing where the formwork is left in place for the minimum specified curing period. Where the formwork is removed before the curing period is completed, formed surfaces shall be cured with burlap and water according to the Curing with Burlap and Water clause for the remainder of the minimum curing period.

For all concrete other than HPC, when ambient air temperatures are 5 °C or less, forms for concrete barrier wall, parapet wall, and curb on deck may be left in place for the duration of the curing period. When forms are left in place, exposed concrete surfaces of these components shall be cured with vapour barrier.

904.07.11 Control of Temperature and Temperature Difference

904.07.11.01 General

The Contractor shall ensure that during the curing period the concrete temperature does not fall below 10 °C or exceed 70 °C. The Contractor shall also ensure that the temperature difference between the centre of the concrete component at a location where the concrete is expected to reach the highest temperature and the surface does not exceed 20 °C, for:

a) Any concrete subject to cold weather.

b) HPC.

c) Large concrete components where the smallest dimension is 1.5 metres.

d) All bridge decks.

904.07.11.02 Monitoring

The Contractor shall monitor the concrete and ambient air temperature for:

a) Any concrete subject to cold weather.

b) HPC.

c) Large concrete components where the smallest dimension is 1.5 metres.

d) All bridge decks.

The Contractor shall supply and install thermocouple wires and associated instrumentation with a combined accuracy of $\pm$ 1 °C capable of recording and displaying temperature. The instrumentation shall include data loggers capable of recording at hourly intervals or less and shall allow direct reading of temperature.

The thermocouples for concrete temperature measurement shall be installed according to Table 2 prior to placing concrete. Thermocouples for monitoring ambient air temperature shall be installed in the shade close to the surface of the concrete at a frequency of 1 thermocouple per stage.

Recording of concrete temperatures shall begin at the start of placement. The temperature shall be recorded automatically at intervals no greater than 1 hour until the end of the monitoring period. The monitoring period shall be 7 Days or longer when necessary in order to meet the requirements of the Withdrawal of Protection clause.

The Contractor shall also monitor and verify concrete and ambient air temperature every 6 hours, or more frequently, for the first 3 Days and every 12 hours for the remainder of the monitoring period. The Contractor shall take necessary action to maintain the temperature within the specified limits.

The Contract Administrator shall be provided access to verify temperature readings. The digital temperature indicators shall be left in place until the end of the monitoring period. If the datalogger does not have a digital display that allows the Contract Administrator to verify temperature, the Contractor shall provide the Contract Administrator with the necessary instruments to allow the Contract Administrator to verify thermocouple function and readings.

904.07.11.03 Concrete Subject to Cold Weather

The Contractor shall design the protection system for the worst conditions that can be reasonably anticipated from local weather records, forecasts, site conditions, and past experience for the time period during which the protection is required. The Contractor shall monitor the conditions and modify the protection system as required.

For cold weather conditions, minimum protection of concrete shall be according to Table 3 and shall be maintained for the duration of curing period. This period may need to be extended in order to meet the requirement of the Withdrawal of Protection clause.

904.07.11.03.01 Housing and Heating

The design of the protective housing shall take into account the effects of construction activities such as placing concrete, stressing, and grouting. Heating equipment of sufficient capacity to establish and maintain the specified curing conditions shall be used throughout the curing period and for such time thereafter as is necessary for the completion of the work. Heating equipment used within the housing shall be vented outside the housing. Heating equipment having an open flame shall not be permitted.

The ambient air temperature adjacent to the concrete or formwork within the housing shall not be permitted to vary by more than 8 °C.

904.07.11.04 Withdrawal of Protection

For concrete subject to cold weather and for large concrete components where the smallest dimension is 1.5 metres, the protection shall be gradually removed or reduced in such a manner that the maximum allowable drop of concrete temperature, as specified in Table 4, for each 24-hour period is not exceeded.

The protection shall not be totally removed nor shall the concrete be fully exposed to the air until the average concrete temperature is within 10 °C of the ambient air temperature.

904.07.12 Removal of Formwork and Falsework

The removal of formwork and falsework shall be according to OPSS 919 and the Contract Documents.

904.07.13 Construction Joints

The Contractor shall form construction joints at the locations shown on the Contract Documents.

In addition, construction joints can be formed where control joints are specified in barrier walls and parapet walls. No other construction joints shall be permitted unless approved in advance by the Contract Administrator.

A straight 20 mm V-groove shall be formed at the exposed face of the concrete at all construction joints. V-grooves shall not be used on bridge deck surfaces, except for the bottom slab of post tensioned box voided slabs.

A bulkhead shall be used to form vertical or inclined construction joints.

904.07.14 Surface Finish

904.07.14.01 General

Concrete surfaces shall not be treated with cement slurry or paste.

Within 3 Days following the removal of forms or curing materials, all holes left in the concrete surface with dimension greater than 15 mm and less than 50 mm shall be filled with mortar or a proprietary patching material. The holes shall be moist at the time of filling. Mortar shall be tamped into place. Proprietary patching materials shall be placed according to manufacturer's instructions.

Surfaces with cavities greater than 50 mm or with honeycombing are considered deficient and shall be repaired. The Contractor shall submit a repair proposal to the Contract Administrator for approval.

904.07.14.02 Exposed Surfaces

The appearance of the concrete shall be uniform in colour, pattern, and texture when viewed from a distance of 15 m. Where a patch is exposed to view, white Portland cement shall be blended with the normal cement to achieve a uniformity of colour. To ensure this uniformity, trial mixes shall be made beforehand and sample panels compared with the main body of the concrete.

The Contractor shall remove all projections, such as fins and bulges, and all blemishes, such as stains and rust marks.

Proprietary patching materials shall be selected to achieve uniformity of colour and appearance.

904.07.14.03 Surface Tolerance

Formed and unformed surfaces shall be such that, when tested with a 3 m long straight edge placed anywhere in any direction on the surface, there shall be no gap greater than 6 mm between the bottom of the straight edge and the surface of the concrete. When the straight edge is placed across a construction joint the gap between the straight edge and the surface of the concrete shall not be greater than 3 mm.

All unformed construction joint surfaces against which sidewalks, curbs, medians, and barrier walls are to be placed shall be such that, when tested with a 500 mm straight edge placed anywhere in any direction on the surface, there is no gap greater than 20 mm between the bottom of the straight edge and the surface of the concrete.

904.07.14.04 Contamination of Surface

Contamination by oil or other deleterious substances shall be prevented. Contaminated concrete in bridge decks or against which new concrete is to be placed shall be removed according to OPSS 928, procedure for Concrete Removal-Partial Depth-Type A, B, and C.

904.07.15 Alignment of Components

The position of the inner and outer top edges of structural components shall be set true to the elevations, alignment, and camber specified in the Contract Documents without visible deviation from one end of the structure to the other. All concrete items or structural components shall be constructed to the specified geometry.

Variations from plumb or a specified slope shall not exceed 1H:400V. Departure from specified alignment shall not exceed $\pm$ 25 mm.

904.07.16 Testing for Early Strength

The Contractor may, at his option, prepare sets of cylinders for early strength determination in addition to the cylinders required for determination of strength at 28 Days.

The Contractor shall be responsible for all aspects of the preparation, storing, and transportation of cylinders for early strength determination. Curing of cylinders for early strength determination shall consist of storing the cylinders in or on the structure as near as possible to the component that they

represent. The cylinders shall receive the same protection from the elements on all surfaces as is given to the portions of the structure that they represent. The Contractor shall identify the time of testing for early-break cylinders and provide the Contract Administrator with 1 Business Day advance notice to arrange testing. The Contractor shall deliver cylinders for early strength determination immediately prior to the time of testing. The Owner shall test a reasonable number of cylinders for early strength determination at the laboratory designated in the Contract.

Early strength determination of concrete in post-tensioned structures shall be carried out on a minimum of four sets of cylinders representative of the concrete placed in the structure. At least one set of cylinders from the start, middle, and end of the deck section being placed, shall be cast. All cylinder test results must reach the minimum stressing strength specified in the Contract Documents before stressing can commence.

904.07.17 Cracks in Formed and Unformed Surfaces

The Contractor shall inspect all concrete to identify and document any cracks including, their location, width, and density. The results of the inspection shall be reported to the Contract Administrator. The Contractor shall continue to inspect and monitor cracks up to the date of Completion of the Work.

Based on criteria in Table 5, the Contractor shall identify areas requiring repair or replacement, and shall identify the limits of such repair or replacement. This information shall be provided to the Contract Administrator along with a proposal for remedial action to be taken. No repairs shall proceed until the proposal has been accepted by the Contract Administrator in writing.

Repairs shall be according to OPSS 932. Where removal is required, the removals and preparation of concrete shall be according to OPSS 928 and OPSS 930.

For bridge decks to be waterproofed, the inspection of the surface to be waterproofed shall be carried out after completion of curing and before application of tack coat for waterproofing. For all other concrete, the inspection shall be carried out in a timely manner but no later than one month following completion of curing. The Contractor shall not proceed with waterproofing of a bridge deck until repairs have been completed and permission to waterproof has been given by the Contract Administrator.

904.07.18 Concrete Cover

The Contractor shall clear all debris and obstructions and provide unhindered access to allow the Contract Administrator to carry out the concrete covermeter survey as specified in the Concrete Cover subsection of the Quality Assurance section. The Contractor shall notify the Contract Administrator in writing when the test area is ready for the concrete covermeter survey.

The Contractor shall allow the Contract Administrator a time period of 3 Business Days to complete the survey, including review of the survey by the Owner. This time period shall commence upon receipt of the Contractor's written notification to carry out the survey. The time period required to complete the concrete survey shall be extended if inclement weather or the ambient air temperatures below 5 °C fall within that time period.

Where the cover does not meet the Contract requirements, the Contractor shall submit a proposal for remedial action for approval by the Contract Administrator.

The Contractor shall not proceed with waterproofing of a bridge deck until the survey has been completed and permission to waterproof has been given by the Contract Administrator.

For all other components, the inspection of the surface shall be carried out in a timely manner, no more than one month after removal of curing.

904.07.19 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

904.08 QUALITY ASSURANCE

904.08.01 Acceptance

Acceptance shall be according to OPSS 1350 and this specification, including satisfactory completion of all remedial action associated with surface tolerance, surface finish, concrete cover, alignment, cracks, and dowel bars and any other deficiencies.

904.08.02 Concrete Cover

The concrete cover shall meet the Contract requirements. Concrete cover determination shall be carried out by the Contract Administrator on the front faces of barrier or parapet walls, and the top surface of decks, including medians and sidewalks. The Contract Administrator shall provide the survey report to the Contractor.

904.08.03 Approach Slab Seat Elastomer

The Contract Administrator shall select a random sample of the approach slab seat elastomer, 600 mm in length, from each structure for testing.

The Contractor shall allow 60 Days from the time of submission of the sample for the Owner's testing program.

The approach slab seat elastomer samples shall be delivered by the Contractor to the Contract Administrator.

Approach slab seat elastomer that does not meet the Contract requirements shall be considered unacceptable.

904.08.04 Dowels into Concrete

904.08.04.01 Acceptance of Dowels into Concrete

If more than one dowel fails, the lot of dowels shall be considered unacceptable and the Contractor shall complete the following:

a) Conduct pull tests on all remaining untested dowels of the lot.

b) On the subsequent lot, conduct pull tests on 10% of dowels or 20 dowels, whichever is greater. If more than one dowel fails, all remaining untested dowels of that lot shall be tested.

c) The subsequent lot shall be tested at the higher frequency until no more than one tested dowel fails.

The Contractor shall pull test all replacement dowels in the presence of the Contract Administrator. Each replacement dowel shall be accepted individually.

Dowels shall not be subjected to more than one pull test.

904.09 MEASUREMENT FOR PAYMENT

904.09.01 General

No deductions from the volume of concrete shall be made for any of the following:

a) Drainage openings, load reducing devices, embedded timbers, and Utility and prestressing steel ducts, each of which has a cross-sectional area of less than 0.1 m^2.

b) Timber, steel, concrete, or concrete filled tubular piles.

c) Steel reinforcement, miscellaneous hardware, and structural steel.

904.09.02 Actual Measurement

904.09.02.01 Concrete in Culverts
Mass Concrete
Tremie Concrete
Concrete in Footings
Concrete in Barrier Wall Footings

Measurement of concrete shall be by volume in cubic metres.

Measurement shall be made within the designated limits of the work.

Tremie concrete volume may be measured using the concrete delivery tickets, when so designated by the Contract Administrator.

904.09.02.02 Dowels into Concrete

For measurement purposes, a count shall be made of the number of dowels installed.

904.09.03 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement

904.10 BASIS OF PAYMENT

904.10.01 Concrete in Culverts - Item
Mass Concrete - Item
Tremie Concrete - Item
Concrete in Footings - Item
Concrete in Barrier Wall Footings - Item
Concrete in Structure - Item
Concrete in Substructure - Item
Concrete in Substructure and Retaining Walls - Item
Concrete in Deck - Item
Concrete in Barrier Walls - Item
Concrete in Parapet Walls - Item
Concrete in Approach Slab - Item
Concrete in Slope Paving - Item
Concrete in Toe Wall - Item
Prestressed Concrete Bridge Deck - Item
High Performance Concrete in Substructure - Item
High Performance Concrete in Structure - Item
High Performance Concrete in Approach Slab - Item
High Performance Concrete in Deck - Item

High Performance Concrete in Barrier Walls - Item
High Performance Concrete in Parapet Walls - Item
High Performance Concrete in Substructure and Retaining Walls - Item

Payment at the Contract price for the concrete tender items shall be full compensation for all labour, Equipment, and Material to do the work, subject to payment adjustments specified in the Contract Documents.

Surface cavities greater than 50 mm and honeycombing shall be repaired at no cost to the Owner.

904.10.02 Dowels into Concrete - Item

Payment at the Contract price for the tender items shall be full compensation for all labour, Equipment, and Material to do the work, except that payment for the reinforcing steel bars or coated reinforcing steel bars or stainless steel reinforcing bars used as the dowels shall be according to OPSS 905.

No payment shall be made for dowels that fail the pull test, except where the failure is due to concrete breakout.

Repair to the concrete required due to Contractor's operations shall be made at no cost to the Owner.

For any dowels that fail the pull test as a result of concrete breakout failure and not by bond failure, payment for repairs to concrete resulting from concrete breakout failure during the pull test and the cost of the replacement dowel shall be made as Extra Work.

The cost of additional testing according to the Acceptance of Dowels into Concrete clause shall be at the Contractor's expense and shall be a lump sum of $1,000 with additional cost of $50 per dowel.

904.10.03 Formwork and Falsework

Payment for formwork and falsework shall be included in the work in which it is used.

Where formwork is required for the work under a concrete tender item, it shall be deemed for progress payment purposes that the formwork, together with its supporting falsework, when installed, constitutes 35% of the work to be carried out under the tender item.

Partial payment for construction of the formwork and falsework shall be made on a prorated basis.

904.10.04 Working Slabs

When a concrete working slab is required by the Contract Administrator, payment shall be made as Extra Work at the unit price of the concrete in the footing to be placed on it.

904.10.05 Deck Joint Assemblies, Bearings, and Deck Drains

When the Contract does not contain a separate tender items for deck joint assemblies, bearings, and deck drains, the Contract price for the concrete tender items in which the deck joint assemblies, bearings, and deck drains are incorporated shall include full compensation for all labour, Equipment, and Material required to place the deck joint assemblies, bearings, and deck drains.

904.10.06 Reinforcing Steel Bars, Coated Reinforcing Steel Bars, or Stainless Steel Reinforcing Bars

When the Contract does not contain a separate tender item for reinforcing steel bar, coated reinforcing steel bar or stainless steel reinforcing bar, the Contract price for the concrete tender item in which the steel reinforcement is incorporated shall include full compensation for all labour, Equipment, and Material required to place the reinforcing steel bars, coated reinforcing steel bars or stainless steel reinforcing bars.

TABLE 1
Pull Test Loads

Dowel Size	Test Loads kN	
	Embedment depth less than 200 mm	Embedment depth 200 mm or greater
10M	20	35
15M	40	70
20M	60	110
25M	100	180
30M	140	250
35M	190	340

TABLE 2
Minimum Number of Thermocouple Sets for Concrete Temperature Measurement

	Concrete Elements Requiring Temperature Monitoring	**Number of Thermocouple Sets in Each Element**	**Number of Thermocouples in Each Set**	**Thermocouple Set Locations**
Cold weather protection	Each concrete element	Minimum of 3 per element or stages thereof	2	In locations where the concrete is expected to reach the highest temperature and at the surface of concrete.
Bridge Decks	All	1) Minimum of 3 per stage, or per deck if deck is not placed in stages. 2) When diaphragm is cast together with a deck a minimum of 4 per stage.	3	The beginning, middle, and final portion of the deck placement and in the diaphragm. In locations where the concrete is expected to reach the highest temperature and at the surfaces of concrete. (Note 1)
HPC	Substructure elements: abutments, pier columns, and pier caps	Minimum of 3 per element or stages thereof	2	In locations where the concrete is expected to reach the highest temperature and at the surface of concrete.
Large concrete components where the smallest dimension is 1.5 metres	Elements with smallest dimension of 1.5 m or more	Minimum of 3 per element or stages thereof	2	In locations where the concrete is expected to reach the highest temperature and at the surface of concrete.

Notes:

1. For bridge decks, thermocouples shall be installed in sets of three consisting of one mid-depth thermocouple and two surface thermocouples. The surface thermocouples shall be placed immediately above or the shortest distance from the corresponding mid-depth thermocouple. The surface thermocouples shall be installed beneath the burlap, in contact with the surface concrete or imbedded in the concrete within 5 mm of the surface and, for bridge decks, the second surface thermocouple shall be placed inside the bottom form.

TABLE 3
Minimum Cold Weather Protective Measures

Footings and Slabs on the Ground				
Anticipated Minimum Ambient Air Temperature °C	**Thickness**			
	> 1.0 m	**1.0 - 0.5 m**	**< 0.5 - 0.25 m**	**< 0.25 m**
+5 to 0	PM1	PM1	PM1	PM2
-1 to -10	PM2	PM2	PM2	PM3
-11 to -20	PM3	PM3	PM4	PM5
less than -20	PM3	PM4	PM5	PM5
All Other Components				
+5 to 0	PM1	PM1	PM1	PM2
-1 to -10	PM2	PM2	PM3	PM4
-11 to -20	PM3	PM3	PM4	PM5
less than -20	PM4	PM5	PM5	PM5

Notes:

A. Protective Measures

PM1 - Cover components with a moisture vapour barrier as specified for curing with moisture vapour barrier.
PM2 - Cover components as for PM1, then cover the moisture vapour barrier with insulation having an R-Value of 0.67.
PM3 - Cover components as for PM1, then cover the moisture vapour barrier with insulation having an R-Value of 1.33.
PM4 - Cover components as for PM1, then cover the moisture vapour barrier with insulation having an R-Value of 2.00.
PM5 - Housing and heating.

B. All R-Values are metric

C. The conversion factor from metric to imperial units is:

Metric R-Value x 5.678 = Imperial R-Value.

TABLE 4
Maximum Allowable Drop in Concrete Temperature

Thickness	**> 2.0 m**	**1.0 - 1.99 m**	**< 1.0 m**
Maximum Allowable Drop in Concrete Temperature per 24 hours	10 °C	15 °C	20 °C

TABLE 5
Criteria for Treatment of Cracks

Components	Width of Crack at Widest Point mm	Treatment of Cracked Areas
Decks to be waterproofed and paved	≥ 0.50	Repair
Exposed decks	> 0.30	a) Repair cracks in the areas where total linear measurement of crack per m^2 is < 5 m. b) Remove and replace the cracked areas where total linear measurement of crack per m^2 is ≥ 5 m.
Barrier wall, parapet wall, sidewalk, and median on a structure	> 0.30	a) Repair cracks in the areas where the total linear measurement of crack per linear meter of the wall, sidewalk or median measured along the side facing traffic is < 5 m. b) Remove and replace the cracked areas where the total linear measurement of crack per lineal meter of the wall, sidewalk, or median measured along the side facing traffic is ≥ 5 m.
	≤ 0.30	Apply sealer acceptable to the ministry to cracked areas where total linear measurement of crack per m^2 is ≥ 5 m.
Curb on a structure	> 0.30	a) Repair cracks in the areas where the total linear measurement of crack per linear meter of the curb is < 1.5 m. b) Remove and replace the cracked areas where the total linear measurement of crack per linear meter of the curb is ≥ 1.5 m.
Piers, pier caps, abutments, and other structural components within 3 m of roadway	> 0.30	Repair
	≤ 0.30	Apply sealer acceptable to the ministry to cracked areas where total linear measurement of crack per m^2 is ≥ 5 m.
All other components	≥ 1.00	Repair

Appendix 904-A, November 2012
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Dowels. (904.05.13)

- Slope paving sealant installation. (904.07.04.05)

- Dowel type. (904.07.05.01)

- Installation of dowels. (904.07.05.02)

- Removal of formwork and falsework. (904.07.12)

- Location of construction joints. (904.07.13)

- Alignment of components. (904.07.15)

- Stressing strength for concrete. (904.07.16)

- Management of excess materials. (904.07.19)

- Payment adjustments for concrete. (904.10.01)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

CONSTRUCTION SPECIFICATION FOR STEEL REINFORCEMENT FOR CONCRETE

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APPENDICES

905-A **Commentary**

905.01 SCOPE

This specification covers the requirements for the placement of steel reinforcement and mechanical connections for concrete structures.

905.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

905.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

905.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 909 Prestressed Concrete - Precast Members
OPSS 910 Stressing Systems for Post-Tensioning

Ontario Provincial Standard Specifications, Material

OPSS 1440 Steel Reinforcement for Concrete

Ontario Ministry of Transportation Publications

Structural Manual

Laboratory Testing Manual:
LS-434 Method of Test for Mechanical Connectors Used to Splice Steel Reinforcement

CSA Standards

G30.18-09	Carbon Steel Bars for Concrete Reinforcement
S6-14	Canadian Highway Bridge Design Code
W186-M1990 (R2012)	Welding of Reinforcing Bars in Reinforced Concrete Construction

ASTM International

A 276-10	Stainless Steel Bars and Shapes
A 416 / A 416M-02	Steel Strand, Uncoated Seven-Wire for Prestressed Concrete
A 421 / A 421M - 10	Uncoated Stress - Relieved Steel Wire for Prestressed Concrete
A 955 / A 955M - 12e1	Deformed and Plain Stainless Steel Bars for Concrete Reinforcement

905.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Engineer means a professional engineer licensed by the Professional Engineers Ontario to practice in the Province of Ontario.

Lot means a quantity of steel that can be identified. For each size designation of prestressing steel strand, a lot shall be reels or coils produced from one heat. For each nominal diameter of prestressing steel bar and for each size designation of reinforcing steel bar, a lot shall be all the supplied bars from one heat.

Mechanical Connection means a joining of two reinforcing steel bars, stainless steel reinforcing bars, or post-tensioning tendons by means of a mechanical connector.

Mechanical Connector - Post-Tensioning means a mechanical device that is used to join post-tensioning tendons.

Post-Tensioning means a method of prestressing in which tendons are stressed after the concrete has reached a predetermined strength.

Prestressing Steel means steel strand or bar that exhibits the principal attributes of high tensile strength and ductility because of its composition and method of production.

Reinforcing Steel Bars means deformed steel bars made of carbon steel as defined in CAN/CSA G30.18, used for the reinforcement of concrete.

Slip means the axial displacement of the reinforcing bars measured relative to the mechanical connector. Displacement is measured at a rebar stress of 5% of specified yield after the mechanical connection has been loaded to a rebar stress of 50% of specified yield and then unloaded to a bar stress of 5% of specified yield.

Splice Bar means a reinforcing steel bar or stainless steel reinforcing bar that is further manufactured, other than by solely cutting threads, to be compatible with a specific mechanical connector.

Stainless Steel Reinforcing Bars means deformed stainless steel bars as defined in ASTM A 955 used for the reinforcement of concrete.

Steel Reinforcement means all types of steel reinforcement for concrete including reinforcing steel bars, stainless steel reinforcing bars, splice bars, welded steel wire fabric, and prestressing strands and bars.

Steel Wire Fabric means a wire mesh fabricated by means of welding the crossing joints, available in rolls or flat sheets.

Strand means a group of wires laid helically over a central-core wire. A seven-wire strand would consist of six outer wires laid over a single wire core.

Structure means any bridge, culvert, tunnel, retaining wall, wharf, dock, or guideway, or any part thereof, or other reinforced concrete component designed to carry loads, including high mast pole footings and sign support footings.

Swaged means to apply circumferential pressure to a sleeve surrounding a bar to deform the sleeve sufficiently to achieve bearing between the deformed sleeve and the deformations on the bar.

Ultimate Tensile Strength means the breaking load of the material per unit area established by tensile testing.

Yield Strength means the stress at which the material exhibits a specified deviation of proportionality of stress and strain.

905.04 DESIGN AND SUBMISSION REQUIREMENTS

905.04.01 Submission Requirements

905.04.01.02 Working Drawings

905.04.01.02.01 Steel Reinforcement Working Drawings

Two hardcopies and an electronic PDF of steel reinforcement Working Drawings shall be submitted to the Contract Administrator for information purposes only at least 7 Days prior to the commencement of placing steel reinforcement. An Engineer's seal and signature shall be affixed on the Working Drawings verifying that they are consistent with the Contract Documents. The Working Drawings shall include at least the following: quantity, bar size, grade, mark number, location, spacing for all steel reinforcement and type if applicable.

When a metric to imperial bar size substitution is made, the placing drawings shall include the quantity, bar size, grade, location, spacing and type if applicable of both the metric and the substitute imperial bar.

When bar marks are indicated on the Contract Documents and reinforcing bar lists show the same bar marks, Working Drawings are not required.

A sealed and signed copy of these drawings shall be kept at the site before and during placing of steel reinforcement.

905.04.01.02.02 Steel Reinforcement Schedule

Two hardcopies and an electronic PDF of steel reinforcement schedules shall be submitted to the Contract Administrator for information purposes only at least 7 Days prior to the commencement of placing steel reinforcement. An Engineer's seal and signature shall be affixed on the Working Drawings verifying that they are consistent with the Contract Documents. The steel reinforcement schedules shall include at least: quantity, bar size, grade, reinforcing steel bars, stainless steel reinforcing bars, type if applicable, length, and bending dimensions.

When bar marks are shown on the Working Drawings, they shall be used in the schedule.

Steel reinforcement shall be detailed according to CAN/CSA-S6, and the Structural Manual.

A sealed and signed copy of the steel reinforcement schedule shall be kept at the site prior to and during placement of steel reinforcement.

905.04.01.03 Prestressed Concrete - Precast Members

Submission of proposals and shop drawings for prestressed concrete-precast members shall be according to OPSS 909.

905.04.01.04 Prestressed Concrete - Post-Tensioning

Submissions for post-tensioning shall be according to OPSS 910.

905.04.01.05 Welding Details

Two hardcopies and an electronic PDF of welding details shall be submitted to the Contract Administrator for information purposes only at least 7 Days prior to the commencement of steel reinforcement welding. An Engineer's seal and signature shall be affixed on the Working Drawings verifying that they are consistent with the Contract Documents. The welding details shall include materials, procedures, bars to be welded, location, and type of welds, as well as details of tack welds. Details shall be designed to prevent notching effects in the bars.

A sealed and signed copy of the welding details shall be kept at the site prior to and during welding of reinforcing.

905.04.01.06 Mechanical Connections Details

Two hardcopies and an electronic PDF of mechanical connection details shall be submitted to the Contract Administrator for information purposes only at least 7 Days prior to the commencement of installation of the connectors. Prior to making a submission, an Engineer's seal and signature shall be affixed on the Working Drawings verifying that they are consistent with the Contract Documents.

The connections details shall contain the following information:

a) The type or series identification of the connector.

b) The grade and size of the reinforcement to be joined by the connector.

c) A copy of the manufacturer's catalogue giving complete data on the connector material and installation procedures.

d) Location of splices, including type of splice.

905.05 MATERIALS

905.05.01 Steel Reinforcement

Steel reinforcement shall be according to OPSS 1440.

905.05.02 Post-Tensioning Materials

Post-tensioning materials shall be according to OPSS 910.

905.05.03 Mechanical Connector Details

905.05.03.01 Post-Tensioning Tendons

When tested in an unbonded condition, mechanical connections for post-tensioning tendons shall develop at least 100% of the ultimate tensile strength of the tendons, without exceeding the anticipated set.

The mechanical connection shall withstand, without failure, two million cycles of stress through a range of 245 MPa for plain bars and 195 MPa for strands and ribbed bars. The upper limit of the range shall be 70% of the nominal tensile strength.

905.05.03.02 Reinforcing Steel Bars, Stainless Steel Reinforcing Bars

The mechanical connections shall be qualified by tests made on sample splices according to the Job Control Test clause.

Mechanical connections for steel reinforcement shall develop, in tension, at least 125% of the specified yield strength of the bars to be used, in the test of the mechanical connection.

The total slip of the reinforcing bars shall not exceed the following measured displacements between gauge points straddling the mechanical connector:

a) for bar sizes up to and including No. 45M 0.25 mm

b) for No. 55M bars 0.75 mm

Splice bars shall be supplied by the manufacturer of the associated mechanical connector.

Stainless steel splice bars shall be used with stainless steel reinforcing bars and shall be of a type according to OPSS 1440.

905.05.04 Mechanical Connectors

905.05.04.01 Post-Tensioning Tendons

Mechanical connectors shall be supplied by the manufacturer of the prestressing system.

905.05.04.02 Reinforcing Steel Bars, Stainless Steel Reinforcing Bars

Mechanical connectors shall be of an approved type and design and may be the form saver type, the filled sleeve type, the sleeve swaged coupler type, the threaded coupler type, the hot rolled thread bar coupler type, or the forged bar coupler type.

Stainless steel mechanical connectors shall be used with stainless steel reinforcing bars and shall be of a type according to OPSS 1440.

905.05.05 Associated Hardware

Only hardware, including spacers and support devices, approved by the Owner shall be used with steel reinforcement and the hardware shall meet the following requirements:

a) All supports or support systems shall be capable of withstanding the loads to be placed on them.

b) Except for tie wire, embedded hardware within 50 mm of exposed surfaces shall be stainless steel, galvanized steel, or of a non-metallic material verified not to react with concrete and approved by the Owner prior to use.

c) Tie wire shall be annealed ferrous wire except for tie wire used to tie stainless steel reinforcing bars to stainless steel reinforcing bars, reinforcing steel bars and shear studs, which shall be Type 316LN or Type 316L stainless steel wire. Tie wire shall be capable of securing reinforcement firmly in place during construction operations. Tie wire shall have a minimum diameter of 1.2mm.

d) Bar chairs for supporting stainless steel reinforcing bars shall be non-metallic. Concrete chairs shall not be used to support stainless steel reinforcing bars.

e) Concrete chairs shall not be used except in footings and against granular surfaces.

905.07 CONSTRUCTION

905.07.01 General

All steel reinforcement and accessories shall be kept clean of mud, oil, and other deleterious materials and stored clear of ground contact.

Steel reinforcement shall be placed in conformance with the tolerances shown in Table 1. The tolerances listed include fabrication tolerances.

905.07.02 Reinforcing Steel Bars, Stainless Steel Reinforcing Bars, and Splice Bars

Bar tags shall be maintained and clearly visible until ready for placement.

905.07.02.01 Storage and Protection of Stainless Steel Reinforcing Bars

Stainless steel reinforcing bars shall be stored separately from reinforcing steel bars.

905.07.02.02 Placing

Reinforcing steel bars and stainless steel reinforcing bars shall be accurately placed in the positions as specified in the Contract Documents and held in position during the operations of placing and consolidating concrete.

Bars shall be tied at least at every fourth intersection. The maximum untied length of any bar shall be 1 m.

For slab-on-girder type decks, the top layer of deck reinforcement shall be tied to the shear studs or shear stirrups on each girder at approximately 1.5 m centres.

Spacers for spirals shall be evenly spaced.

905.07.02.03 Surface Condition

Steel reinforcement other than stainless steel reinforcing bars with rust, mill scale, or a combination of both shall be acceptable, provided the minimum physical properties including height of deformations and mass of a wire brushed test specimen are not less than the applicable specification requirements. Loose scale shall be removed.

Stainless steel reinforcing bars at the time the concrete is placed shall be free of deposits of iron and non-stainless steels.

905.07.02.04 Cutting

The cutting of stainless steel reinforcing bars, reinforcing steel bars, and splice bars by oxyacetylene torch may be carried out only where permitted in writing by the Contract Administrator.

905.07.02.05 Bending

Field bending of stainless steel reinforcing bars and reinforcing steel bars shall not be permitted, except when specified in the Contract Documents or authorized by the Contract Administrator.

905.07.02.06 Welding

Welding, including tack welding, shall not be permitted except as specified in the Contract Documents or as shown on the welding details submitted to the Contract Administrator.

The welding of stainless steel reinforcing bars and reinforcing steel bars shall be according to CSA W186 and shall be performed by companies certified by the Canadian Welding Bureau according to CSA W186.

Welding shall not be permitted within 3 m of any prestressing steel. Grounding welding equipment to prestressing steel or sheath shall not be permitted.

Except for splicing of stainless spirals, welding of stainless steel reinforcing bars shall not be permitted.

905.07.02.07 Splicing

Welded splices shall develop 100% of the tensile strength of the bar.

Splices for stainless steel reinforcing bars and reinforcing steel other than spirals shall be made as specified in the Working Drawings.

End anchorage of column spiral reinforcement shall be provided either by one and one half extra turns of spiral bar at each end of the spiral, one end embedded in the footing and the other end in the component supported above, or by a 90 degree bend around a longitudinal reinforcing bar plus an extension of at least 24 bar diameters into the core of the column.

Splicing of spiral reinforcing bars by means of a non-welded splice shall be made as specified in the Working Drawings. Non-welded splices shall be done means of mechanical connections or anchoring the ends of the spiral bars by means of a 90 degree bend around a longitudinal reinforcing bar with extensions of at least 24 bar diameters into the core of the column.

905.07.02.08 Mechanical Connections

Mechanical connections shall only be permitted as specified in the Contract Drawings.

Locations of mechanical connections shall be as specified in the Working Drawings.

When a mechanical connector type is specified in the Contract Documents, only the specified mechanical connector type shall be used for that application.

The form saver type of mechanical connector shall only be used at construction joints.

The mechanical connections shall be qualified by tests made on sample splices according to the Job Control Test clause.

All procedures and equipment for mechanical connections shall be according to the manufacturer's recommendations.

Ends of reinforcing bars to be joined shall be cut nominally square.

Connector sleeves shall have the clear cover as specified for the reinforcing steel in that location.

Stirrups, ties, and other reinforcement shall be adjusted or relocated, if necessary, to provide the required clear cover to the reinforcement.

Threads cut on the ends of the reinforcing steel bars shall match the internal threads in the connector.

905.07.02.08.01 Job Control Test

When mechanical connectors are used, sample connections shall be assembled at the work site in the presence of the Contract Administrator. Frequency of sampling and method of sample assembly shall be according to the Quality Assurance section. Sample connections for testing shall be assembled on site in exactly the same manner as the connectors used in the work. Sample connections fully assembled anywhere other than on site and in the presence of the Contract Administrator shall not be submitted for testing.

Samples for testing shall be submitted at least 10 Days prior to intended start of concrete placement.

905.07.02.08.02 Inspection of Mechanical Connectors

The Contractor shall provide the Contract Administrator two Days' notice prior to the projected completion of the installation of mechanical connectors to allow the Contract Administrator to complete the inspection of the work.

905.07.03 Prestressing Steel for Prestressed Concrete

Prestressing steel shall be according to OPSS 910

905.07.04 Stressing Systems for Post-Tensioning

Construction requirements for stressing systems for post-tensioning shall be according to OPSS 910.

905.07.05 Inspection of Reinforcement

The Contractor shall provide the Contract Administrator two Days' notice prior to the projected completion of the installation of reinforcement to allow the Contract Administrator to complete the inspection of the work.

905.07.06 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

905.08 QUALITY ASSURANCE

905.08.01 Sampling

905.08.01.01 Prestressing Steel

Sampling of the prestressing steel shall be as per OPSS 910

905.08.01.02 Reinforcing Steel Bars and Stainless Steel Reinforcing Bars

The sampling of reinforcing steel bar shall be at the discretion of the Contract Administrator and shall be on a random basis.

The sampling of stainless steel reinforcing bars shall consist of three bars, 1.5 m long, randomly selected samples of each bar size supplied in a lot, and shall be submitted to the Contract Administrator with the mill certificates for that lot.

The Contractor shall deliver the samples of reinforcing steel bar and stainless steel reinforcing bars to the Owner's designated laboratory or as directed by the Contract Administrator.

905.08.01.03 Mechanical Connectors - Sampling for Job Control Test

At the discretion of the Contract Administrator, mechanical connectors shall be sampled for acceptance on a lot basis. A lot shall consist of all connectors of one size and type from one supplier. If a lot contains more than 300 connectors, it shall be divided into sublots of a maximum of 300 connectors. Sublots shall be of approximately equal size.

The Contractor shall assemble six sample connections per sublot or six sample connections per lot if there are less than 300 connectors. The reinforcing bars from which the test samples are to be fabricated shall be selected on a random basis at the site by the Contract Administrator. The length of each bar to be joined shall be at least 500 mm. The same materials, position, location, equipment, and procedures as are being used to make connections in the reinforcing bars in the work shall be used when making the sample connections.

The Contractor shall complete Form PH-CC-812, Field Sample Data Sheet-Mechanical Connectors, for each assembled sample. The Contractor shall submit the samples and the completed forms along with mill test certificates corresponding to the bars used, to the Contract Administrator for delivery to the laboratory designated by the Owner.

905.08.02 Testing

905.08.02.01 Prestressing Steel

The testing of prestressing steel shall be according to ASTM A 421.

The testing of prestressing steel strand and bars shall be according to ASTM A 416.

905.08.02.02 Reinforcing Steel Bar and Stainless Steel Reinforcing Bar

The testing of reinforcing steel bar and stainless steel reinforcing bar shall be according to ASTM A 276 and A 955.

905.08.02.03 Mechanical Connections

905.08.02.03.01 Testing for Torque

The torque shall be checked on 5% of the splices. Formwork that limits access to connectors for testing purposes shall not be placed until testing has been completed.

905.08.02.03.02 Job Control Test

Three of the six sample connections for each lot or sublot shall be tested for acceptance and the remaining three samples shall be retained by the testing laboratory for referee testing, if invoked.

The samples shall be tested for slip and tensile strength according to the Ontario Ministry of Transportation laboratory test method LS-434.

If one or more of the three test samples fails to meet the requirements of this specification for either the slip or tensile strength, the lot or sublot represented by the samples shall be rejected.

Individual test results shall be forwarded to the Contractor, as they become available.

905.08.02.03.03 Job Control Test - Referee Testing

Referee testing of mechanical connectors may be invoked by the Contractor, at no extra cost to the Owner, within five Days of receiving the test result.

When referee testing is invoked, the three retained referee samples will be tested by the referee laboratory designated by the Owner . The samples shall be tested for slip and tensile strength according to LS-434.

Referee test results shall be forwarded to the Contractor, as they become available.

If one or more of the referee samples fails to meet the requirements of this specification for either the slip or tensile strength, the Acceptance Testing results are confirmed and shall be the basis of acceptance.

When all three referee samples meet the requirements of this specification for slip and tensile strength, the Acceptance Testing results are not confirmed and the referee test results shall replace the Acceptance Testing results as the basis of acceptance.

905.08.02.03.04 Referee Testing Cost

The cost of mechanical connector referee testing shall be as specified in the Contract Documents. When the referee results indicate that the acceptance test results for refereed lot or sublot are not confirmed, the Owner shall bear the cost. When the referee results indicate that the acceptance test results for refereed lot or sublot are confirmed, the Contractor shall be charged the cost of mechanical connector testing.

905.09 MEASUREMENT FOR PAYMENT

905.09.01 Actual Measurement

905.09.01.01 Mechanical Connectors
Stainless Steel Mechanical Connectors

For measurement purposes, a count shall be made of the number of connectors installed.

905.09.02 Plan Quantity

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

905.10 BASIS OF PAYMENT

905.10.01 Reinforcing Steel Bar - Item
Stainless Steel Reinforcing Bar - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

905.10.02 Mechanical Connectors - Item
Stainless Steel Mechanical Connectors - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

TABLE 1
Tolerances for Cover and Placing Accuracy

TYPE		TOLERANCE mm	
		CAST-IN-PLACE CONCRETE	**PRECAST CONCRETE**
STEEL REINFORCEMENT		**Cover to Surface of Concrete and Placing Accuracy** (Notes 1 and 2)	
a)	Principal Steel Reinforcement	± 20	± 10
b)	Concrete Cast Against and Permanently Exposed to Earth	± 25	
c)	Stirrups in Webs		+ 5, - 3
d)	Stirrups, Ties, Spirals	± 20	± 10
e)	Deck Slab i) Top ii) Bottom	 ± 20 ± 10	 ± 15 ± 10
f)	Remainder	± 30	± 30
g)	Lateral spacing in slabs and walls	± 30 Note 3	± 30 Note 3
h)	Longitudinal location of bends and ends of bar in continuous member	± 50	± 50
i)	Longitudinal location of bends and ends of bar at discontinuous end	± 20	± 20
PRESTRESSING STEEL		**Placing Accuracy Horizontal and Vertical**	
a)	Prestressing strands or bars		± 5

Notes:

1. The cover to the concrete surface shall not be reduced by more than one-third of the specified cover.

2. The clear distance between bars shall not be less than one and one-half times the nominal diameter of the bar, one and one-half times the nominal size of the coarse aggregate, or 40 mm.

   In two or more layers, the rebar shall be directly above one another and the clear distance between layers shall not be less than 25 mm.

   The tolerances e) through f) do not apply to the lateral spacing of bars in slabs and walls.

3. The number of bars specified per metre width shall be placed in the metre width.

Appendix 905-A, November 2017
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

The designer should determine if any of the following are required and, if so, specify them in the Contract Documents.

- Where field re-bending of bars is permitted, if required. (905.07.02.05)

- Where welding of steel reinforcement is permitted, if required. (905.07.02.06)

- Specify location and type of Mechanical connections, if required. (905.07.02.08)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

CONSTRUCTION SPECIFICATION FOR STRUCTURAL STEEL FOR BRIDGES

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906.10 **BASIS OF PAYMENT**

APPENDICES

906-A **COMMENTARY**

906.01 SCOPE

This specification covers the construction requirements for the fabrication, delivery, and erection of structural steel for highway bridges.

906.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be as specified in the Contract Documents.

906.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

906.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 911	Coating Structural Steel Systems
OPSS 919	Formwork and Falsework
OPSS 922	Installation of Bearings

Ontario Provincial Standard Specifications, Materials

OPSS 1202	Bearings-Elastomeric Plain and Steel Laminated
OPSS 1203	Bearings-Rotational and Sliding Surface

Ontario Ministry of Transportation Publications

Structural Manual

CSA Standards

B95-1962 (R2002)	Surface Texture (Roughness, Waviness and Lay)
G40.20/40.21-13 (R2018)	General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel
S6-19	Canadian Highway Bridge Design Code
W47.1-19	Certification of Companies for Fusion Welding of Steel
W48-18	Filler Metals and Allied Materials for Metal Arc Welding
W59-18	Welded Steel Construction (Metal Arc Welding)
W178.1-18	Certification of Welding Inspection Organizations
W178.2-18	Certification of Welding Inspectors

ASTM International

A108-18	Steel Bar, Carbon and Alloy, Cold-Finished
A563M-07(2013)	Carbon and Alloy Steel Nuts (Metric)
A588/A588M-19	High-Strength Low-Alloy Structural Steel, up to 50 ksi [345 MPa] Minimum Yield Point, With Atmospheric Corrosion Resistance
A709/A709M-18	Structural Steel for Bridges
F436/F436M-19	Hardened Steel Washers Inch and Metric Dimensions
F3125/F3125M-19e2	High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength

International Organization for Standardization/International Electrotechnical Commission (ISO/IEC)

17025:2017	General Requirements for the Competence of the Testing and Calibration Laboratories

Joint Publications of the Society for Protective Coatings (SSPC) and National Association of Corrosion Engineers (NACE)

SSPC-SP6/NACE No. 3-2007	Commercial Blast Cleaning

Canadian General Standards Board (CGSB)

CAN/CGSB-48.9712-2014 (ISO 9712:2012, IDT)	Non-destructive Testing – Qualification and Certification of NDT Personnel

906.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Bearing Contact Area means two planes that are in contact or have a separation between them not exceeding 0.12 mm.

Erection Diagrams means drawings showing the dimensioned layout of the steel structure, from which shop details are made, and that correlate the fabricator's piece markings with the location in the structure.

Faying Surface means the mating surface of a member that is in contact with another member to which it is to be joined.

Flush means a profile of weld reinforcement in which there is a smooth gradual transition between the base and weld metal involving grinding where necessary. Weld reinforcement not exceeding 1 mm in height may remain on each surface, unless the weld is part of a faying surface when all reinforcement is removed.

Fracture Critical Member means a member, including attachments, in a single load path structure that is subject to tensile stress and whose failure could lead to collapse of the structure.

Inspector means an individual who is a Canadian Welding Bureau (CWB) certified Level 2 or Level 3 Inspector according to the requirements of CSA W178.2 and has documented evidence of professional knowledge, skill, and experience in the inspection of fabrication and erection of steel bridges.

Manufacturer's Certificate of Conformance means a letter issued by an Engineer confirming that the fabrication and required testing has been carried out on a component or product in general conformance with the Contract Documents. Form is OPSF 906-1.

New Steel means structural steel that has not previously been used.

Non-Destructive Testing Technician means an individual who has documented evidence of training, professional knowledge, skill, and experience in non-destructive testing of structural steel welds and material, and has a valid certificate showing qualification to a Level 2 or 3 according to CAN/CGSB 48.9712 for the non-destructive testing specified.

Notice to Proceed means a form issued by the Contract Administrator notifying the Contractor to proceed to the next operation. Form is OPSF 906-3.

Primary Tension Member means a member including attachments that are subject to tension stress.

Request to Proceed means a form issued by the Contractor notifying the Contract Administrator that a component or stage of the work has been completed in general conformance with the Contract Documents. Form is OPSF 906-2.

Smooth means a profile of weld reinforcement, in which the surface finish or weld reinforcement has sufficiently smooth gradual transition, involving grinding where necessary. Weld reinforcement not exceeding the following limits, may remain on each surface:

2 mm for plate thickness ≤ 50 mm
3 mm for plate thickness > 50 mm

Snug Tight means the tightness that is attained with a few impacts of an impact wrench or the full effort of an ironworker using an ordinary spud wrench to bring the connected plies into firm contact.

906.04 DESIGN AND SUBMISSION REQUIREMENTS

906.04.01 Design Requirements

906.04.01.01 General

Design shall be according to CSA S6 and the Structural Manual.

906.04.01.02 Welding

Welding design shall be according to CSA W59.

Welding procedures shall be according to CSA W47.1 and CSA W59, except where modified by CSA S6, Clause A10.1.5.

Symbols for welding and non-destructive testing shall be according to CSA W59.

906.04.02 Submissions

906.04.02.01 General

When other authorities are involved in the approval of the design or construction of a highway structure, submissions shall be made at least 35 Days prior to commencement of work and one additional copy of the submission shall be provided for each authority.

The requirements of each authority shall be satisfied prior to commencement of fabrication.

906.04.02.02 Shop Drawings and Welding Procedures

Three sets of the shop drawings and welding procedures shall be submitted to the Contract Administrator at least seven Days prior to commencement of fabrication, for information purposes only. Prior to making a submission, an Engineer's seal and signature shall be affixed on the shop drawings and welding procedures verifying that the details and procedures are in general conformance with the Contract Documents.

The shop drawings shall include at least the following:

a) Full detail dimensions and sizes of all component parts of the structure. These dimensions shall make allowance for changes in shape due to weld shrinkage, camber, and any other effects that cause finished dimensions to differ from initial dimensions.

b) Identification marking of each member for erection.

c) All necessary specifications and standards for the materials to be used.

d) Identification of areas requiring special surface treatment.

e) Identification of fracture-critical and primary tension members and component parts. Attachments having a length of more than 100 mm in the direction of tension and welded to the tension zone of a fracture-critical or primary tension member shall be treated as part of that member.

f) Bolt installation requirements, including number of fitting up bolts required at each connection and oversize and slotted holes.

g) Details of all welds, including the identification of any welds which require a surface finish of smooth or flush.

h) Identification of material and welds requiring non-destructive testing, including the limits of the weld undergoing testing and the frequency and type of testing.

i) Temporary welds.

j) Location of shop and field splices.

Fabrication shall not commence until the fabricator has received one set of shop drawings and welding procedures sealed and signed by an Engineer.

A copy of the shop drawings and welding procedures shall be at the fabrication facility during fabrication.

906.04.02.03 Erection Diagrams and Erection Procedure Drawings and Calculations

Three sets of the erection diagrams and erection procedure drawings and calculations shall be submitted to the Contract Administrator at least seven Days prior to commencement of erection, for information purposes only. Prior to making a submission, an Engineer's seal and signature shall be affixed on the erection diagrams and erection procedure drawings and calculations verifying that the erection diagrams and erection procedure drawings and calculations are consistent with the Contract Documents.

Erection diagrams and erection procedure drawings shall include at least the following:

a) Principal dimensions of the bridge.

b) Identification marking of each member for erection.

c) Sizes of all members.

d) Field welding requirements, including identification of welds requiring non-destructive testing.

e) Size and type of bolts.

f) Bolt installation requirements, including the number of fitting up bolts required at each connection and identification of oversize and slotted holes.

g) Bracing during erection of structural steel.

h) Treatment at faying surfaces for joints designed as slip critical.

Erection shall not commence until one set of erection diagrams and erection procedure drawings and calculations sealed and signed by an Engineer have been received.

A copy of the erection diagrams and the erection procedure drawings and calculations shall be at the site during erection.

906.04.02.04 Mill Test Certificates

Prior to the use of any material in fabrication, two copies of the mill test certificates for that material shall be submitted to the Contract Administrator, confirming that the material is according to the Contract Documents.

Copies of the mill test certificates for all material to be used in the fabrication shall be available for review at the fabricating plant during fabrication. The certificates shall show that the material is according to the Contract Documents.

Material used in fabrication shall be directly traceable to the mill test certificate. When material is divided, identification marking shall be transferred to all pieces.

When mill test certificates originate from a mill outside of Canada or the United States of America, the information on the mill test certificate shall be verified by testing at a Canadian laboratory. This laboratory shall be certified by an organization accredited by the Standards Council of Canada to comply with the requirements of ISO/IEC 17025 for the specific tests or type of tests required by the material standard specified on the mill test certificate. The Canadian laboratory's test certificate shall be identified with the name of the laboratory and appropriate wording stating that the material is according to the specified Contract requirements. The certificate shall include the appropriate material specification number, testing date (i.e., yyyy-mm-dd), signature of an authorized officer of the Canadian laboratory, and be traceable to the original mill test certificate. Material coupons to be tested in the Canadian Laboratory for the purpose of verifying mill test certificates originating from a mill outside of Canada or the United States of America shall be taken from the material sample once the material has arrived in Canada.

906.04.02.05 Test Reports for Fasteners

Proof that the bolts, nuts, and washers meet the chemical composition, mechanical properties, dimensions, workmanship, and head burst as required by ASTM F3125, ASTM A563, or ASTM F436 shall be submitted to the Contract Administrator. Verification of the acceptability of assemblage of zinc-coated bolts, nuts, and washers delivered to the job site shall also be submitted to the Contract Administrator.

For bolts, nuts, and washers supplied from a manufacturer outside Canada or the United States of America, the above information shall be verified by testing at a Canadian laboratory as outlined in the Mill Test Certificates clause.

906.04.02.06 Independent Testing Organization and Technician Information

The name of the independent testing organization and the non-destructive testing technicians, together with proof of certification, shall be submitted to the Contract Administrator a minimum of seven Days prior to the commencement of fabrication, for information purposes only.

906.04.03 Inspection after Fabrication of the Structural Steel

A Manufacturer's Certificate of Conformance and a Request to Proceed shall be submitted to the Contract Administrator upon completion of the fabrication of the structural steel and prior to shipping from the fabrication facility. Structural steel shall not be delivered from the plant until the Contract Administrator has received the Manufacturer's Certificate of Conformance, Request to Proceed, and issued a Notice to Proceed.

906.05 MATERIALS

906.05.01 Steel

Structural steel shall be new steel and of the grade and category specified in the Contract Documents and shall be according to CSA G40.20/G40.21.

ASTM A588 may be substituted when either of the following steel grades have been specified:

a) CSA G40.20/G40.21, Grade 350A.

b) CSA G40.20/G40.21, Grade 350AT, when the Charpy impact energy requirements are verified by the submission of test documentation.

ASTM A709, Grade 345 or Grade 345S may be substituted when either of the following steel grades have been specified:

a) CSA G40.20/G40.21, Grade 350W.

b) CSA G40.20/G40.21, Grade 350WT, when the Charpy impact energy requirements are verified by the submission of test documentation.

Substitution of other material for size and grade is not permitted unless approval is received from the Contract Administrator.

Material testing shall confirm that all structural steel to be used in welded fabrication contains less than 0.0008% boron. Boron content shall be reported on the mill test certificate. When verification by testing at a Canadian laboratory is required as outlined in the Mill Test Certificate clause, the boron content shall also be verified and reported.

The steel shall be identified as specified in the Control of Material clause.

906.05.02 High Strength Bolts, Nuts, and Washers

High strength bolts shall be according to ASTM F3125, Grade A325M or Grade A490M.

High strength nuts, and hardened washers shall be suitable for use with the types of bolts being specified and shall be according to ASTM A563 and ASTM F436.

The nuts, bolts, and washers shall be supplied and shipped together as an assembly from the same manufacturer.

High strength bolts, nuts, and washers for use with unpainted corrosion-resistant steel shall be Type 3. Bolts, nuts, and washers used with steel specified in the Contract Documents to receive a paint coating or galvanizing shall be Type 1 and shall be galvanized. High strength Grade A490M bolts shall not be galvanized or plated.

906.05.03 Electrodes

Welding electrodes, electrode and flux or electrode and gas combinations shall be low hydrogen (level H16 or less) and shall be according to CSA W47.1, CSA W48, and Section 12 of CSA W59.

The weld metal shall meet the Charpy V notch impact energy requirements of CSA S6, Table 10.15 for fracture-critical members and Table 10.14 for primary tension members.

Weld metal used with corrosion resistant steels shall have similar corrosion resistance and colour to the base metal and shall be according to CSA W59.

906.05.04 Stud Shear Connectors

Stud shear connectors shall meet the requirements of ASTM A108 Grades G10100 to G10200 and CSA W59, Annex H. Only studs of Type B as defined by CSA W59, Annex H, shall be used.

906.05.05 Pins and Rollers

Pins and rollers more than 175 mm in diameter shall be forged and annealed or forged and normalized. Pins and rollers 175 mm or less in diameter shall be forged and annealed, forged and normalized, or cold-finished carbon-steel shafting.

906.05.06 Bearings

Bearings shall be according to OPSS 1202 or OPSS 1203 or both.

906.07 CONSTRUCTION

906.07.01 Fabrication

906.07.01.01 General

The fabrication shall be according to CSA S6, Clause A10.1.4.

All Atmospheric Corrosion Resistant (ACR) steel components shall be abrasive blast-cleaned according to SSPC-SP6/NACE No. 3 to completely remove mill scale, rust, coating, oxides, corrosion products, oil, grease, dust, dirt, and other foreign matter.

906.07.01.02 Plate Edges

Plasma arc cutting of plates up to and including 25 mm in thickness is permitted. Plasma arc cutting of plates thicker than 25 mm shall not be permitted unless approval is received in writing from the Contract Administrator. Plasma arc cutting of plates shall use oxygen as the cutting gas and all edges shall be square and free of dross.

The quality of cut edges and the inspection and repair of planar discontinuities shall be according to CSA W59.

Corners of oxygen cut girder flanges shall be chamfered 1.5 to 2.0 mm by grinding.

906.07.01.03 Straightening Material

Material with sharp kinks shall be rejected. Straightening of bends shall only be done using mechanical means or by the application of controlled heating according to CSA W59. Details of the straightening procedure including testing requirements, sealed and signed by an Engineer shall be submitted to the Contract Administrator prior to the straightening, for information purposes only.

Straightening shall only be carried out in the presence of the Owner's Inspector. The Contract Administrator shall be given seven Days prior notice to arrange for the inspection.

If necessary, the Contract Administrator shall specify additional testing to be performed by the Contractor. If evidence of damage is discovered, the material shall be rejected, and the cost of testing shall be at the expense of the Contractor.

906.07.01.04 Cambering

When rolled sections are heat cambered, the details of the heat cambering procedure, sealed and signed by an Engineer, shall be submitted to the Contract Administrator seven Days prior to cambering, for information purposes only.

Plate girders shall have the required camber cut into the web with suitable allowance for camber loss due to cutting and welding.

Steel box girders fabricated with webs in an upright position shall have the fabricated camber verified by subtracting ordinates for deflections for girder segments from the relaxed camber diagram ordinates.

The use of heat to alter the camber of fracture critical or primary tension members shall be subject to approval by the Contract Administrator prior to the application of heat.

The ends of cambered girders shall be vertical under full dead load.

906.07.01.05 Horizontally Curved Girders

906.07.01.05.01 Heat Curving of Rolled Beams and Welded Girders

Girders shall be cambered before heat curving.

A detailed procedure for the heat curving operation, sealed and signed by an Engineer, shall be submitted to the Contract Administrator 14 Days prior to heat curving, for information purposes only.

906.07.01.06 Identification Marking for Erection

Each member shall carry an erection mark for identification.

Permanent marking shall be affixed in an area not exposed to view in the finished structure.

906.07.01.07 Welded Construction

906.07.01.07.01 General

All welded construction shall be according to CSA W59 and Clause A10.1.5 of CSA S6.

All welding shall be carried out by welders having a CSA W47.1 identification card valid for the type of welding to be done and for the duration of the welding work.

The fabrication weld metal requirements, base metal repairs, and repairs of weld in fracture critical and primary tension members shall be according to CSA S6, Clause 10.23.6.

Any company responsible for welding structures fabricated or erected according to CSA S6 shall be certified according to CSA W47.1, Division 1 or 2.

906.07.01.07.02 Altering the Sweep of Fracture-Critical and Primary Tension Members

The use of heat to alter the sweep of fracture critical or primary tension members shall be subject to approval by the Contract Administrator, prior to the application of heat.

906.07.01.07.03 Submissions of Repair Procedures

Canadian Welding Bureau (CWB) approved welding procedure specifications, data-sheets, and repair procedures for prequalification sealed and signed by an Engineer, shall be submitted for approval to the Contract Administrator 14 Days prior to commencement of work.

906.07.01.07.04 Assembly for Welding

Assembly for welding shall be according to CSA W59 and the following:

a) Bearing stiffeners shall be vertical under full dead load.

b) Intermediate stiffeners shall be either true vertical or perpendicular to the horizontal work lines used to layout the girder.

c) Bearing stiffeners fitted to bear shall have a minimum bearing contact area of 75% and a maximum separation of 1 mm over the remaining area.

d) Fitted intermediate stiffeners shall have a minimum bearing contact area of 25% and a maximum separation of 2 mm.

906.07.01.07.05 Temporary Welds

Temporary welds shall not be used on fracture-critical and primary tension members.

Temporary welds shall not be used on flange material in compression, unless approved by the Contract Administrator.

906.07.01.07.06 Preheat, Interpass Temperature, and Heat Input Control

When making welding repairs to fracture-critical and primary tension members, the preheat requirements shall be according to CSA S6, Table 10.16.

906.07.01.07.07 Profile of Welds

Profile of welds shall be according to CSA W59 and the Structural Manual.

906.07.01.07.08 Corrections

Welding corrections and repairs to fracture-critical and primary tension members shall be according to CSA S6, Clause 10.23.6.

Any steel members subjected to shape corrections or straightening shall be allowed to cool in still air.

906.07.01.07.09 Peening

Peening, when required, shall be subject to approval by the Contract Administrator.

906.07.01.07.10 Stress Relief-Heat Treatment

Stress relief-heat treatment temperatures shall be recorded using thermo-couples or other methods acceptable to the Contract Administrator. A record showing temperature and time data of the heat-treating operation shall be maintained and be made available to the Contract Administrator upon request.

906.07.01.07.11 Welding Inspection

906.07.01.07.11.01 General

All welding inspection shall be according to CSA W59.

906.07.01.07.11.02 Identification Cards - Canadian Welding Bureau

Prior to commencement of welding, the Canadian Welding Bureau's transferable or non-transferable identification cards for each tacker, welder, or welding operator to be employed on the work shall be made available to the Contract Administrator. Such identification cards shall be currently valid and shall indicate the welding processes and the welding positions at which the personnel are qualified to weld.

906.07.01.07.11.03 Certification of the Independent Testing Organization

The independent organization undertaking welding testing under the Quality Control subsection shall be certified for testing bridges according to CSA W178.1. The certification shall encompass at least the following methods: radiographic, ultrasonic, and magnetic particle.

906.07.01.07.11.04 Certification of the Non-Destructive Testing Technician

The independent organization’s non-destructive testing technician undertaking non-destructive testing of welds under the Quality Control subsection shall be certified according to CAN/CGSB 48.9712 Level 2 or Level 3 for the methods used.

906.07.01.07.12 Welding Corrections and Repairs for Fracture-Critical and Primary Tension Members

906.07.01.07.12.01 General

All repair procedures requiring approval shall be submitted to the Contract Administrator at least 14 Days prior to commencement of the work.

Repair procedures shall be according to CSA S6, Clause 10.23.6.

906.07.01.07.12.02 Approval for Non-Critical Repairs

Non-critical repairs are those listed in CSA S6, Clause 10.23.6.

Repair procedures shall be prepared and submitted to the Contract Administrator. Work on the repair shall not commence until the Contract Administrator has given written approval to proceed.

906.07.01.07.12.03 Approval for Critical Repairs

Repair procedures that are beyond those described in CSA S6, Subclause 10.23.6.4 are considered critical and shall be individually approved by the Contract Administrator before repair welding proceeds.

Critical repairs include those listed in CSA S6, Clause 10.23.6.

906.07.01.07.13 Non-Destructive Testing of Fracture Critical Members

The fabricator shall maintain documentation of all visual and non-destructive testing for review and verification by the Contract Administrator. Documentation shall be submitted to the Contract Administrator upon completion of the project.

906.07.01.07.14 Repair of Welds

Any section of weld that does not meet the acceptance standards shall be removed, re-welded, and re- examined.

906.07.01.07.15 Bolted Construction

906.07.01.07.15.01 General

Bolted construction shall be according to CSA S6, Clause A10.1.6.

Once all bolts in a joint or connection are brought to a snug tight condition and all plies are in firm contact, the nuts and the protruding bolt ends shall be match marked using an indelible paint marker before final tightening to enable the amount of relative rotation to be determined by the bolting Inspector.

Bolts shall be sufficiently long to exclude threads from the shear plane.

906.07.01.07.15.02 Plasma Arc Cutting of Holes

Plasma arc cutting of holes shall only be permitted in plates up to and including 20 mm in thickness. Plasma arc cut holes shall be produced by mechanically guided means and the diameter of the holes shall be greater than or equal to the thickness of the plate. When plasma arc cutting of holes is permitted, the cutting gas as well as the shielding gas shall be oxygen and the surface roughness shall not exceed 25 microns (1000 micro-inches) as defined in CSA B95 Occasional gouges not more than 1.5 mm in depth are permitted. Thermally cut holes shall be 2 mm larger than the nominal diameter of the bolt and the taper shall not exceed 0.5 degrees.

906.07.01.07.15.03 Holes Drilled Using Numerically Controlled Machines

As an alternative to the shop trial assembly requirements of CSA S6 when numerically controlled machines have prepared the boltholes, a check assembly consisting of the first components of each type of bolthole pattern to be made shall be undertaken to adequately demonstrate the accuracy of the drilling. If the check assembly is satisfactory, further assemblies of like components are not required. If the check assembly is unsatisfactory, the work shall be redone or repaired in a manner acceptable to the Contract Administrator.

906.07.01.07.15.04 Inspection

Inspection shall be according to CSA S6 as required.

906.07.01.07.16 Tolerances

906.07.01.07.16.01 Dimensional and Workmanship Tolerances

Dimensional and workmanship tolerances shall be according to CSA W59 and Clause A10.1.7 of CSA S6.

906.07.02 Delivery

A delivery schedule shall be provided to the Contract Administrator not less than five Days prior to shipping. The Contract Administrator shall be provided with the status of any oversized/overweight shipping permits.

Delivery shall include loading of the members, transportation, unloading, storage at the storage site and temporary works for access.

Structural steel shall be loaded for shipping in such a manner that it can be transported and unloaded at its destination without being excessively stressed, deformed, or otherwise damaged.

Plate girders shall be transported with their webs in a vertical plane. When girders cannot be shipped with their webs in the vertical plane, static and dynamic forces during handling, transportation, and storage shall be determined using a dynamic load allowance of 100%. Computed stresses shall be according to CSA S6, Clause 10.10 and the maximum cyclic stress range shall not exceed the constant amplitude fatigue threshold for the appropriate fatigue categories specified in CSA S6, Table 10.4. All the calculations and associated sketches, including reasons why the girders cannot be shipped with the webs in the vertical plane, shall be submitted by the Contractor to the Contract Administrator for approval seven Days prior to shipping. The calculations and sketches shall be sealed and signed by an Engineer.

Structural steel, when stored, shall be stored in a manner to avoid excessive stress deformation or other damage.

Advertising by means of removable signing is permitted on elements only while in transit to the specified site. Any permanent markings on a surface that would be visible after installation shall not be permitted.

906.07.03 Erection

906.07.03.01 General

The Contract Administrator shall be notified in writing of the starting erection date at least 14 Days prior to the commencement of field operations.

Erection shall be according to CSA S6, Clause A10.1.10. Additional permanent material may be provided to ensure that the member capacities are not exceeded during erection, if approved by the Contract Administrator. The additional material shall be shown in the erection diagram.

Repairs to erected material shall only be permitted after the Contract Administrator has approved the repair procedure.

Welding shall not be used to fill misplaced holes.

Hammering that can damage or distort the members is not permitted.

906.07.03.02 Falsework

Falsework shall be according to OPSS 919.

906.07.03.03 Connections

Holes made in the field shall be drilled or sub-drilled and reamed.

Any error that prevents the proper assembly and fitting of parts shall be reported and the proposed method of correction shall be submitted to the Contract Administrator. Corrective measures shall not commence until the submitted proposal is accepted.

Bolt heads shall be located on the outside faces of the exterior girders.

Bolt heads in field splices for box girders shall be located on the exterior surfaces.

906.07.03.04 Maintaining Alignment and Camber

The bridge shall be erected to the alignment and elevations specified in the Contract Documents.

906.07.03.05 Bearings

The installation of bearings shall be according to OPSS 922.

906.07.03.06 Coatings

Coating of new structural steel shall be according to OPSS 911.

906.07.04 Quality Control

906.07.04.01 General

Quality control shall be according to CSA S6, Clause A10.1.8. The acceptance standards of CSA W59 for dynamically loaded structures shall also apply.

In addition to quality control measures instituted by the Contractor, the Contractor shall be responsible for the quality control procedures specified herein.

906.07.04.02 Control of Material

A record for each component shall be kept identifying the material as to heat number, corresponding mill test certificate, and colour coding or other identification markings.

906.07.04.03 Visual Inspection

The Contractor's Inspector shall carry out full visual inspection.

906.07.04.04 Non-Destructive Testing

906.07.04.04.01 General

An independent testing organization shall carry out all non-destructive testing of the welds for bridge structures by using radiographic, ultrasonic, magnetic particle, and liquid penetrant test methods as applicable.

A non-destructive testing technician shall do the testing.

Neither the technician nor the independent testing organization shall be changed without the approval of the Contract Administrator.

906.07.04.04.02 Notification of Testing

The independent testing organization shall be given at least five Days notice of when the work is ready for testing. Such notice shall include the type and quantity of work to be tested.

906.07.04.04.03 Testing of Welds

Radiographic, ultrasonic, or magnetic particle testing shall be carried out using procedures according to CSA W59.

The amount and location of welding to be tested shall not be less than:

a) Visual inspection of all welds.

b) Radiographic or ultrasonic inspection of groove welds in flanges and webs of built-up girders:

   i. Flange splices in tension or stress reversal zones: 100% of all welds.
   ii. Flange splices in compression zones: 100% of the weld of 1 in 4 splices.
   iii. Web splices for 1/2 the depth from the tension flange: 100% of the weld length for each weld.
   iv. Web splices for 1/2 the depth from the compression flange: 100% of the weld length of 1 in 4 splices.

   If defects are found during testing of compression zones, two additional zones shall be tested for each zone exhibiting defects.

c) Magnetic particle inspection of web-to-flange fillet welds:

   i. Submerged-arc welds - 25% of length of each weld.
   ii. Semi-automatic welds - 50% of length of each weld.
   iii. Manual welds - 100% of length of each weld.

d) Magnetic particle inspection of fillet welds in connection plates and stiffeners to which diaphragms or cross bracing are attached:

   i. For 1/2 the depth from the tension flange: 100% of weld length of each weld.
   ii. Transverse welds on tension flanges: 100% of weld length of each weld.

e) Arc strikes shall be lightly ground and checked for cracks by magnetic particle inspection.

Radiographic and ultrasonic testing shall be performed prior to the assembly of the flanges to the webs.

906.07.05 Repair of Welds

Any section of weld that does not meet the acceptance standards shall be removed, re-welded, and re-examined.

906.07.06 Inspection Reports

Inspection reports shall be sealed and signed by an Engineer.

Inspection reports shall be made available to the Owner's Inspector upon request. Copies of all inspection reports shall be submitted to the Contract Administrator within seven Days of inspection.

906.07.07 Erected Girder Elevations

The top of flange elevations and top of splice plate elevations specified in the Contract Documents shall be checked and recorded and shall be submitted to the Contract Administrator within seven Days.

906.07.08 Inspection after Installation of the Structural Steel

A Request to Proceed shall be submitted to the Contract Administrator after the installation of the structural steel.

The next operation shall not proceed until a Notice to Proceed has been received from the Contract Administrator.

906.07.09 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

906.08 QUALITY ASSURANCE

906.08.01 General

Visual inspection, non-destructive testing, and sampling shall be done in the fabrication shop and in the field by an Owner's Inspector to confirm the material supplied, fabrication, and erection has been done as specified in the Contract Documents.

Electric power, scaffolding, protection from the weather, and free access for inspection and testing of material, to all aspects of the fabrication, delivery, and erection of the structural steel shall be supplied.

906.10 BASIS OF PAYMENT

906.10.01 Fabrication of Structural Steel - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

906.10.02 Delivery of Structural Steel - Item
Erection of Structural Steel - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

906.10.03 Shop and Field Inspection and Testing

The supply of electric power, scaffolding, protection from the weather, and access for material testing and inspection shall be the Contractor’s responsibility at no extra cost to the Owner.

906.10.04 Bearings

Payment for the supply and installation of bearings shall be according to OPSS 922.

When the Contract does not contain a separate item for bearings and bearings are not paid as part of any concrete tender item according to OPSS 904, the Contract price for the erection of structural steel shall include full compensation for all labour, Equipment, and Material to supply and install the bearings.

MANUFACTURER'S CERTIFICATE OF CONFORMANCE

Contract Number: ……..……

Contractor: ……..……

Location / Structure: ……..……

Plant / Manufacturer: ……..……

Work, Component(s)/Element, or Product: ……
……
……

I, _____ (print name), P. Eng. _____ (Professional Engineers of Ontario License Number) certify that the above-noted part of work, component, or product have been constructed in general conformance to the requirements of the Contract Documents.

(Attach documents per Contract Documents (examples: test results, production records) outside of form)

Seal and Signature

_____
Date

DISTRIBUTION: 1) Contractor
2) Contract Administrator or Project Manager File

OPSF 906-1 (March 2021)

REQUEST TO PROCEED

Contract Number:		**Request to Proceed Number:**	
Contractor Name:		**Consultant Name:**	
Location / Structure Site:			
Description of the work:			
Work / Component(s) or Product:			
Applicable specification(s) /special provision(s):			

This is to confirm that the above stage of work, component or product has been completed according to the general requirements of the Contract Documents.

Submitted by: _____ Time & Date: _____
Contractor's Representative
(Printed Name and Signature)

Received by: _____ Time & Date: _____
Contract Administrator or Project Manager
(Printed Name and Signature)

DISTRIBUTION: 1) Contractor
2) Contract Administrator or Project Manager File

OPSF 906-2 (March 2021)

NOTICE TO PROCEED

Contract Number:		**Request to Proceed Number:**	
Contractor Name:		**Consultant Name:**	
Location / Structure Site:			
Description of the work:			
Work / Component(s) or Product:			
Applicable specification(s) /special provision(s):			

The Contractor may proceed to the next operation as of the date of this notice.

Any Notice to Proceed by the Owner or its Contract Administrator or Project manager of the Work and Materials of the Contractor does not relieve the Contractor from any responsibility or obligation for the proper performance of the Work in general conformity with the requirements of the Contract Documents. As well, the Notice to Proceed imposes no liability upon the Owner or its Contract Administrator or Project Manager and is not to be interpreted as an approval or acceptance of the Work or the Materials by the Owner that the Work and Materials was completed or supplied in general conformance with the Contract Documents.

Issued by: _____ Time & Date: _____
Contract Administrator or Project Manager
(Printed Name and signature)

Received by: _____ Time & Date: _____
Contractor's Representative
(Printed Name and signature)

DISTRIBUTION: 1) Contractor
2) Contract Administrator or Project Manager File

OPSF 906-3 (March 2021)

Appendix 906-A, November 2021
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Grade and category of structural steel. (906.05.01)

- Bridge alignment and elevation. (906.07.03.04)

- Girder top flange and top splice plate elevations. (906.07.07)

- Location of hatches as per OPSD 3311.900 to confirm shear capacity of reduced section.

Clause 906.04.03 requires the use of OPSF 906-1 as a Manufacturer's Certificate of Conformance, OPSF 906-3 as a Request to Proceed, and OPSF 906-3 as a Notice to Proceed. Clause 906.07.08 requires the use of OPSF 906-2 as a Request to Proceed, and OPSF 906-3 as a Notice to Proceed. If any form(s) other than OPSF 906-1, OPSF 906-2, or OPSF 906-3 will be used for submission purposes, the alternate form(s) should be invoked by reference in the Contract Documents and the specification should be amended to remove reference to the OPSF(s).

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 3311.100	Deck Girders, Steel, Method of Obtaining Screed Elevations
OPSD 3311.900	Deck Girders, Steel Box, Access Hatch

Note: The MUNI published in November 2021 replaces OPSS 907 COMMON, April 2011 with no technical content changes.

CONSTRUCTION SPECIFICATION FOR STRUCTURAL WOOD SYSTEMS

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907-A **Commentary**

907.01 SCOPE

This specification covers the requirements for structural wood systems.

907.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

907.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

907.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 501	Compacting
OPSS 902	Excavating and Backfilling - Structures
OPSS 904	Concrete Structures
OPSS 905	Steel Reinforcement for Concrete
OPSS 910	Stressing Systems for Post-Tensioning

Ontario Provincial Standard Specifications, Material

OPSS 1010	Granular - Base, Subbase, Selected Subgrade and Backfill Material
OPSS 1350	Concrete - Materials and Production
OPSS 1440	Steel Reinforcement for Concrete
OPSS 1601	Wood - Material, Preservative Treatment and Shop Fabrication
OPSS 1860	Geotextiles

Ontario Ministry of Transportation Publications

Structural Manual

CSA Standards

B111-1974 (R2003)	Wire Nails, Spikes and Staple
G40.20-04/G40.21-04 (R2009)	General Requirements for Rolled or Welded Structural Quality Steel/ Structural Quality Steel
G164-M92 (R2003)	Hot Dip Galvanizing of Irregularly Shaped Articles
O86-09	Consolidation, Engineering Design in Wood
S6-06	Canadian Highway Bridge Design Code

ASTM International

A47/A47M-99 (2009)	Ferritic Malleable Iron Castings
A307-10	Carbon Steel Bolts and Studs, 60000 psi Tensile Strength
A653/A653M-10	Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot Dip Process
A722/A722M-07	Uncoated High-Strength Steel Bar for Prestressed Concrete

907.03 DEFINITIONS

For the purpose of this specification, definitions in OPSS 1601 and the following definitions apply:

Engineer means a professional engineer licensed by the Professional Engineers Ontario to practice in the Province of Ontario.

Fastener means hardware used to connect wood members or components.

Girders means generally very large size beams and stringers or glued-laminated member for use in bending with load applied to the narrow face.

Groove and Dap means the wood base of a wood-concrete composite deck using alternating height laminations where the higher laminate is grooved and dapped according to CAN/CSA-S6.

Laminated Wood Deck means dimension lumber placed side by side on its narrow face to form a wood slab.

Lamination means dimension lumber sizes when used in a laminated wood deck.

Longitudinally Laminated Deck means a deck where the wood laminations are placed on edge and oriented parallel to the longitudinal centreline of the deck.

Notch and Spike means the wood base of a wood-concrete composite deck using uniform height laminations, where all laminations have square notches reinforced with spikes according to CAN/CSA-S6.

Reinforcing Spike means a common nail used to reinforce the shear key in notch and spike wood-concrete composite decks.

Stress-Laminated Wood Deck means a laminated wood deck, which is held together by pressure applied perpendicular to the laminations using high-strength bars according to CAN/CSA-S6.

Stringers means sawn wood that has a minimum thickness of 114 mm and a width at least 51 mm greater than the thickness for use in bending with load applied to the narrow face.

Transversely Laminated Deck means a deck in which the wood laminations are placed on edge and oriented transversely to the longitudinal centre line of the deck.

Truss Plates means a sheet of steel that has been punched by a special die, where the displaced material forms sharp teeth, used to connect laminations at butt joints in wood-concrete composite decks.

Wood-Concrete Composite Deck means a deck that has a laminated wood base made composite with a reinforced concrete overlay.

907.04 DESIGN AND SUBMISSION REQUIREMENTS

907.04.01 Submission Requirements

907.04.01.01 General

All Working Drawings, stressing details, and calculations shall bear the seal and signature of an Engineer.

At least 14 Days prior to commencement of work, 5 copies of any proposal shall be submitted to the Contract Administrator.

When other authorities are involved in the approval of the design or construction of a highway structure, the submission shall be made at least 5 weeks prior to commencement of the work. One additional set is required to be submitted for each authority.

907.04.01.02 Submission of Working Drawings for Fabrication and Fastening Details

At least 4 weeks before the commencement of fabrication, the Contractor shall submit 5 complete sets of the Working Drawings to the Contract Administrator.

Fabrication details shall include the following:

a) The grade and species of all wood components and all necessary specifications.

b) The type of preservative treatments to be used for all wood components, including the penetration, and retention required.

c) Details of shop fabrication.

d) Details of all fabrication to be performed in the field.

e) Details of all field cuts and field boring.

f) Special handling or protection details required in the shop, during shipping, or in the field.

g) The field installation details of any temporary attachments such as running planks, barricades, and railings.

h) Protective treatment of heat-treated alloy components.

i) Fastening details.

907.04.01.03 Submission of Erection Procedures

Erection procedures shall bear the seal and signature of an Engineer.

At least 4 weeks before commencement of erection, the Contractor shall submit to the Contract Administrator, 5 complete sets of the erection procedures, including lifting point locations, details of all temporary supports, and prestressing procedures.

907.04.01.04 Return of Submissions

Two copies of each submission to be returned shall be marked as one of the following:

a) Stamped with wording that allows for permission to construct.

In this case, work can commence upon the Contractor's receipt of the Working Drawings. A copy of the Working Drawings shall be available at the site prior to and during construction.

b) Stamped with wording that allows for permission to construct as noted.

In this case, work can start upon the Contractor's receipt of the Working Drawings. The Working Drawings shall be updated as noted and shall have a stamp affixed that is signed by an Engineer stating that the Working Drawings have been revised according to the noted comments. A copy of the stamped updated Working Drawings shall be available at the site prior to and during construction.

c) Showing only required changes.

In this case, the Working Drawings shall be updated as required and the submission process repeated.

907.05 MATERIALS

907.05.01 Wood

Wood shall be according to OPSS 1601.

907.05.02 Preservatives

The preservatives shall be according to OPSS 1601.

For wood structural systems in bridges, preservatives shall also be according to the CAN/CSA-S6 and the Structural Manual.

907.05.03 Fasteners and Hardware

907.05.03.01 Bolts, Rods, and Lag Screws

Bolts, rods, and lag screws shall be according to ASTM A307 or CSA G40.20/G40.21.

907.05.03.02 Truss Plates

Sheet steel for manufacturing truss plates shall be according to ASTM A653, Type A or Type B.

907.05.03.03 Split Ring and Shear Plate Connectors

Split ring and shear plate connectors shall be according to CSA O86.

907.05.03.04 Glulam Rivets

Glulam rivets shall be according to CSA O86.

907.05.03.05 Nails and Spikes

Nails and spikes shall be according to CSA B111.

907.05.03.06 Drift Pins

Steel used for drift pins shall have minimum yield strength of 280 MPa and shall be according to CSA G40.20/G40.21.

907.05.03.07 Washers

Steel washers shall be according to CSA G40.20/G40.21. Malleable iron casting washers shall be according to ASTM A47M.

907.05.03.08 High-Strength Bars

High-strength bars shall be according to ASTM A722M.

907.05.03.09 Galvanizing

All fasteners and hardware shall be hot dip galvanized according to CSA G164, after manufacture.

Heat-treated alloy components shall be galvanized according to the manufacturer's specifications.

907.05.04 Granular Materials

Granular materials shall be according to OPSS 1010.

907.05.05 Geotextile

Geotextile shall be non-woven, Class II according to OPSS 1860, Table 1, with an FOS of 75-150 µm.

907.05.06 Concrete

Concrete shall be according to OPSS 1350 with a minimum 28-Day specified compressive strength of 30 MPa.

907.05.07 Steel Reinforcement

Steel reinforcement for concrete shall be according to OPSS 1440.

907.06 EQUIPMENT

907.06.01 Hydraulic and Mechanical Press

Hydraulic or mechanical presses capable of applying uniform pressure over the whole area of truss plates shall be used for the installation of all truss plates.

907.06.02 Hydraulic Jack System Stress-Laminated Wood Decks

The stressing equipment shall be according to OPSS 910.

The hydraulic jack system shall be capable of stressing a minimum of six post-tensioning locations at a time. For longitudinally laminated decks, the number of jacks shall not be less than those required to stress a length of deck equal to one half the width of the deck at the same time.

907.07 CONSTRUCTION

907.07.01 Handling and Storage of Wood

All wood shall be handled, stacked, and protected according to OPSS 1601.

907.07.02 Shop Fabrication

Shop preparation and fabrication shall be according to OPSS 1601.

907.07.03 Field Fabrication

Field fabrication shall only be permitted when specified in the Contract Documents.

Field cut portions of treated wood members shall not be buried or placed in contact with the ground.

Cutting and boring shall not puncture the internal voids of bridge decks containing the post-tensioning bars.

Field cuts, abrasions, and boreholes made in fabricated wood after preservative treatment shall be trimmed and treated to be according to OPSS 1601.

907.07.04 Fasteners

907.07.04.01 Bolts, Rods, and Lag Screws

Holes shall be prebored as specified in the Contract Documents. Holes shall be aligned and the bolts and rods shall be driven, with a hammer not larger than 0.5 kg, in order to make the connection. Lag screws shall be turned into the wood, not driven.

Holes for smooth dowels and drift pins shall be 1.5 mm less in diameter than the dowels or pins. Holes for galvanized bolts shall be bored with a bit 1.5 mm larger in diameter than the bolt.

Holes for lag screws shall have the same diameter and depth as the shank of the screw, plus a lead hole for the threaded portion with the diameter approximately 75% of the shank diameter.

Washers shall be placed under all bolt heads and nuts. Excess bolt lengths of more than 50 mm shall be cut off to a level where at least 5 threads are still extending beyond the nut. The cut ends of galvanized bolts shall receive 2 coats of zinc rich paint. After final tightening, all nuts shall be checked and threads burred effectively with a pointing tool to prevent loosening. Field cuts or damaged surfaces shall be touched-up with a zinc rich paint within 10 hours of exposure.

907.07.04.02 Nailing for Laminated Decks

Gauge lines for horizontal nailing shall be followed. Nails in the upper gauge line shall be inclined slightly downward and those in the lower gauge line inclined slightly upward. The nailheads shall be flush and well set so that they do not protrude from the surface. Power nailing devices shall be permitted for stress-laminated wood decks according to the CAN/CSA-S6.

907.07.05 Wood in Cribs

Excavation shall be according to OPSS 902.

Cribs shall be erected to the dimensions shown in the Contract Documents with each layer horizontal before placing the next. Wood with the least surface oils shall be located in or nearest to the water. Wood, which appears to be more heavily treated, shall be placed at the back of the crib against the ground.

The cribs shall be filled to 1 m below the top of the crib with boulder or rock fragments having dimensions in the range 200 to 600 mm. The top metre of the cribs shall be filled with Granular A or B. The granular material shall be protected against migration into the rock layer by the placement of geotextile fabric between the rock and the granular layers. The geotextile shall be placed uniformly, free of tears and as specified in the Contract Documents. All seams shall have a minimum overlap of 500 mm and the geotextile shall be fixed to prevent movement. Filling of the cribs shall be such that distortion is avoided. Fill material shall be placed in even horizontal layers and shall be compacted according to the requirements of OPSS 501.

907.07.06 Placement of Members

907.07.06.01 Stringers and Girders

Stringers and girders shall be placed and adjusted when necessary so that full and accurate bearing is achieved on the supports. Sawn wood members shall be oriented so that elevation differences between adjacent members, due to natural curvatures along their lengths, are minimized.

907.07.06.02 Laminated Wood Deck

Each lamination shall be placed in the bridge so that initially, full and accurate bearing is achieved. Subsequently the alignment of predrilled holes in stress-laminated decks or slots in composite wood-concrete decks shall be achieved. Finally, the laminations shall be brought to position by nailing.

907.07.07 Stress-Laminated Wood Decks

907.07.07.01 Stressing

Hydraulic jacks shall be used for stressing the stress-laminated wood decks. For transversely laminated decks, all tendons shall be uniformly stressed at the same time.

High-strength bars shall be stressed to the forces shown in the Contract Documents. The tensioning shall be performed in the following sequence:

a) Initial stressing - at time of construction of deck.

   The initial stressing shall consist of two stressing operations not less than 12 hours apart.

b) 1st restressing - not less than 2 weeks after completion of the initial stressing.

c) 2nd Restressing - not less than 4 weeks after the 1st restressing.

The allowable variation of prestressing force in each bar shall be 5%.

The Contract Administrator may increase the time periods between restressings, when the ambient temperature is below 0 °C.

907.07.07.02 Securing of Deck

The deck shall not be secured to the supporting members, except as specified in the Segmental Construction clause, until after the 1st restressing. When a deck requires restraint against buckling during stressing, the restraint shall not inhibit free movement of the deck perpendicular to the laminates.

907.07.07.03 Segmental Construction

When a deck is to be constructed in segments, each segment shall undergo all restressings as specified in the Stressing clause before being installed. The method of installation of the segments shall be such that the final assembled deck is continuous.

When the method of installation requires the temporary release of stressing in a segment in order to facilitate installation, that segment shall then be stressed twice before any segments are attached to it. The first stressing shall be at the time of installation of that segment. The second stressing shall be performed no sooner than 4 x T after the first stressing, where T equals the total time period the segment was not under stress.

907.07.08 Wood-Concrete Composite Decks

907.07.08.01 Wood Base Construction

Wood-concrete interface construction of the deck shall be according to CAN/CSA-S6.

907.07.08.02 Concrete

Concrete placement and testing shall be according to OPSS 904.

907.07.08.03 Steel Reinforcement

Steel reinforcement for concrete shall be placed according to OPSS 905 and CAN/CSA-S6.

907.07.08.04 Reinforcing Spikes

Reinforcing spikes, for notch and spike construction, shall be driven into the top of the laminations in every notch of alternate laminations. These spikes shall be inclined at about 30° from the vertical toward the nearest internal support or end support. If the notches in adjacent laminations are staggered by more than 50 mm, then all laminations involved shall contain reinforcing spikes. Reinforcing spikes shall be a minimum of 50 mm longer than the full vertical depth of the wood deck.

907.07.09 Management of Excess Material

Management of excess material shall be as specified in the Contract Documents.

907.09 MEASUREMENT FOR PAYMENT

907.09.01 Actual Measurement

907.09.01.01 Wood in Cribs

Measurement of wood in cribs shall be by volume in cubic metres using dressed dimensions of the wood with no deductions for grooves, notches, and holes.

907.09.02 Plan Quantity Measurement

When measurement is by plan quantity, such measurement shall be based on the units shown in the clause under Actual Measurement.

907.10 BASIS OF PAYMENT

907.10.01 Wood in Structure - Item
Wood in Cribs - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

When rock is available on the Contract, no deduction shall be made from the tender item “Rock Excavation, Grading,” for the quantity of rock used in cribs.

907.10.02 Excavation for Wood Cribs

When excavation for wood cribs overlaps excavation for other work, measurement of the overlapping excavation shall be according to the specification for such other work.

Appendix 907-A, November 2021
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The following should be specified in the Contract Documents:

- Allowable field fabrication. (907.07.03)

- Prebored holes for bolts, rods, and lag screws. (907.07.04.01)

- Crib details. (907.07.05)

- Geotextile placement details. (907.07.05)

- Stressing forces for high-strength bars. (907.07.07.01)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

CONSTRUCTION SPECIFICATION FOR METAL RAILINGS FOR STRUCTURES

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908.10 **BASIS OF PAYMENT**

APPENDICES

908-A **Commentary**

908.01 SCOPE

This specification covers the requirements for metal railings and inspector guard for structures including posts and anchorage assembly.

908.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

908.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

908.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 906	Structural Steel for Bridges
OPSS 911	Coating Structural Steel Systems

Ontario Ministry of Transportation Publications

Designated Source for Materials (DSM)

CSA Standards

G40.20/G40.21-04 (R2018)	General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steels
O80 Series-08 (R2012)	Wood Preservation
S6:19	Canadian Highway Bridge Design Code
W47.1-19	Certification of Companies for Fusion Welding of Steel
W47.2-11 (R2020)	Certification of Companies for Fusion Welding of Aluminum
W59-18	Welded Steel Construction
W59.2-18	Welded Aluminum Construction

ASTM International

A27/A27M-20	Standard Specification for Steel Castings, Carbon, for General Application
A108-18	Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished
A123/A123M-17	Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

A153/A153M-16a	Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
A307-14	Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength
A500/A500M-20	Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
A563-15	Standard Specification for Carbon and Alloy Steel Nuts
A780/A780M-09(2015)	Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
B108/B108M-19	Standard Specification for Aluminum-Alloy Pavement Mold Castings
B117-19	Standard Practice for Operating Salt Spray (Fog) Apparatus
B209M-14	Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
B221M-13	Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles and Tubes
B695-04(2016)	Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel
D4541-17	Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
F593-17	Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
F594-09(2020)	Standard Specification for Stainless Steel Nuts
F844-19	Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use
F880M-16	Standard Specification for Stainless Steel Socket Set Screws (Metric)
F3125/F3125M-19	Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength

SSPC, American Welding Society (AWS) and NACE Joint Publications

SSPC-CS 23.00 / AWS C2.23M / NACE No.12-2016	Specification for the Application of Thermal Spray Coatings (Metallizing) of Aluminum, Zinc, and Their Alloys and Composites for Corrosion Protection of Steel

908.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Anchorage Assembly means an assembly of metal plates, rods/bolts, nuts and washers installed with posts to anchor metal railing/inspector guard system into concrete.

Barrier Wall Railing means a metal railing that is anchored to the top of a concrete barrier wall and is part of a barrier system that has undergone the barrier appraisal requirements of CSA-S6.

Bicycle Railing means an all-metal railing system mounted on a structure that is designed to meet the bicycle barrier requirements of CSA-S6.

Combination Railing means a metal railing that is fastened to concrete barrier designed to meet the combination barrier requirements of CSA-S6.

Inspector Guard means metal safety guard anchored to the concrete abutment seat, walls or RSS coping to protect the inspector from a fall during inspection and has been designed to meet the Ontario Building Code requirements.

Manufacturer's Certificate of Conformance means a letter issued by an Engineer confirming that the fabrication and required testing has been carried out on a component or product in general conformance with the Contract Documents. Form is OPSF 906-1.

Metal Railing is a generic term used for metal part of parapet wall, barrier wall, pedestrian, bicycle, or combination railing.

Notice to Proceed means a form issued by the Contract Administrator notifying the Contractor to proceed to the next operation. Form is OPSF 906-3.

Parapet Wall Railing means a metal railing that is fastened to the top of a concrete parapet wall and is part of a traffic barrier system that has undergone the barrier appraisal requirements of CSA-S6.

Pedestrian Railing means an all-metal railing system mounted on a structure that is designed to meet the pedestrian barrier requirements of CSA-S6.

Request to Proceed means a form issued by the Contractor notifying the Contract Administrator that a component or stage of the work has been completed in general conformance with the Contract Documents. Form is OPSF 906-2.

908.04 DESIGN AND SUBMISSION REQUIREMENTS

908.04.01 Submission Requirements

908.04.01.01 General

Three sets of Working Drawings shall be submitted to the Contract Administrator, prior to commencement of fabrication of the metal railing and/or inspector guard, for information purposes only. Prior to a submission, an Engineer's seal and signature shall be affixed on the Working Drawings verifying that the drawings are as specified in the Contract Documents.

When multi-discipline engineering work is depicted on the same Working Drawing and a single Engineer is unable to seal and sign the Working Drawing for all aspects of the work, the drawing shall be sealed and signed by as many additional Engineers as necessary.

The manufacturer shall not commence fabrication of the metal railing or the inspector guard until receiving a sealed and signed copy of the Working Drawings. A copy of these drawings shall be retained at the manufacturing plant during the fabrication.

A sealed and signed copy of the metal railing and/or inspector guard Working Drawings shall be at the site prior to and during installation of the metal railing and/or inspector guard.

908.04.01.02 Inspection after the Fabrication of Metal Railing and Inspector Guard

A Manufacturer's Certificate of Conformance and a Request to Proceed for each individual shipment shall be submitted to the Contract Administrator upon completion of fabrication of the metal railing and inspector guard and prior to shipping from the plant.

Metal railing and inspector guard for each individual shipment shall not be delivered from the plant until the Contract Administrator has received the Manufacturer's Certificate of Conformance, Request to Proceed, and issued a Notice to Proceed.

908.04.01.03 Mill Test Certificates

Mill test certificates shall be submitted according to OPSS 906.

908.04.01.04 Test Reports for Fasteners and Anchorages

Test reports demonstrating that the bolts, anchorages, nuts, and washers meet the chemical composition, mechanical properties, dimensions, workmanship, and head burst as specified in the Contract Documents shall be submitted to the Contract Administrator. Verification of the acceptability of assemblage of zinc-coated bolts, anchors, nuts, and washers delivered to the job site shall be submitted to the Contract Administrator.

For bolts, anchors, nuts, and washers supplied from a manufacturer outside of Canada or the United States of America, the above information shall be verified by testing at a Canadian laboratory according to the Mill Test Certificates clause of OPSS 906.

908.05 MATERIALS

908.05.01 Metal Railings

908.05.01.01 Steel Railing and Steel Posts

Steel shall be according to CSA G40.20/G40.21.

Rails and posts shall be Grade 350W or 350WT as specified in the Contract Documents.

Steel plate shall be Grade 300W or 350W as specified in the Contract Documents.

Galvanized bolts and nuts shall be according to ASTM A307 or ASTM F3125/F3125M, Grade A325 as specified in the Contract Documents.

Studs shall be according to ASTM A108. Lock nuts shall be according to ASTM A563. Washers shall be according to ASTM F844.

Cast steel posts shall be according to ASTM A27, Grade 65-35.

Paint shall be as specified in the Contract Documents.

908.05.01.02 Aluminum Railing and Aluminum Posts

Extruded aluminum tubing shall be 6061-T6 or 6351-T6 alloy according to ASTM B221M.

Aluminum sheet and plate shall be 6061-T6 alloy according to ASTM B209M.

Cast Posts shall be A444.0-T4 heat-treated according to ASTM B108. Extruded posts shall be 6061-T6 or 6351-T6.

908.05.01.03 Stainless Steel Fasteners

Bolts shall be according to ASTM F593, Type 304 or 316 stainless steel with matching nuts according to ASTM F594 and matching washers. Set screws shall be according to ASTM F880M, Type 304 or 316 stainless steel.

908.05.01.04 Galvanized Hardware

L-bolt assemblies shall be according to ASTM A307 and include hex nuts, flat washers, and lock washers. The assemblies shall be galvanized according to ASTM A153/A153M.

908.05.02 Inspector Guard

Steel railing and posts shall be according to ASTM A500 Grade C, or CSA G40.20/G40.21 Grade 300W.

Steel plate shall be Grade 300W or as specified in the Contract Documents.

Galvanized bolts and nuts shall be as specified in the Contract Documents.

Lock nuts shall be according to ASTM A563. Washers shall be according to ASTM F844.

Coating shall be as specified in the Contract Documents.

908.05.03 Anchorage Assembly

Anchorage assemblies shall be as specified in the Contract Documents.

The anchorage assembly shall be supplied with the bolts installed in a template.

908.05.04 Grout

Grout shall be non-staining, non-shrink cement based grout or non-staining, non-shrink epoxy based grout, and shall be as specified in the Contract Documents.

908.05.05 Hot Dip Galvanizing

Purity of the zinc and the galvanizing bath composition for hot dip galvanizing of steel railing and Inspector Guard components shall be according to ASTM A123/A123M.

908.05.06 Zinc-Rich Touch-Up Paint

Zinc-rich touch-up paint shall be according to CAN/CGSB 1.181 or the ministry’s DSM.

908.05.07 Thermal Sprayed Metal Coatings

Thermal sprayed metal coatings shall be according to SSPC-CS 23.00 / AWS C2.23M / NACE No.12. The metallizing wire for thermal metal spray coatings shall be an alloy consisting of 85% zinc and 15% aluminum.

908.05.08 Zinc-Tin-Copper Solder

The zinc-tin-copper solder shall be 50% zinc, 49% tin, and 1% copper used with the manufacturer's recommended flux.

908.07 CONSTRUCTION

908.07.01 Fabrication of Metal Railings and Inspector Guard

908.07.01.01 General

The railing system and inspector guard components shall be fabricated as specified in the Working Drawings. Field modification shall only be done when approved by the Contract Administrator.

The fabricator shall be certified according to CSA W47.1, Division 1 or Division 2 for steel railings or CSA W47.2, Division 1 or Division 2 for aluminum railings.

908.07.01.02 Steel Components

908.07.01.02.01 Fabrication

908.07.01.02.01.01 General

Fabrication and welding shall be according to OPSS 906 and CSA W59. All welding inspection shall be according to CSA W59.

All flame cut edges shall be as smooth and regular as those produced by edge planing and shall be free of slag.

908.07.01.02.02 Surface Preparation for Hot Dip Galvanizing

The metal railing and inspector guard components shall be cleaned according to OPSS 911 prior to galvanizing.

908.07.01.02.03 Hot Dip Galvanizing

Hot dipped galvanizing of steel railing and inspector guard components shall be according to OPSS 911.

908.07.01.02.04 Zinc and Zinc-Nickel Plating

Setscrews shall have zinc-nickel plating applied to a thickness of 10 µm. The plating shall show no red rust after 1,000-hour exposure to salt spray according to ASTM B117.

Lock nuts shall be zinc plated according to ASTM B695.

908.07.01.02.05 Paint Coating of Galvanized Surfaces

When specified, paint coating of galvanized surfaces shall be according to OPSS 911.

908.07.01.02.06 Repair of Damage to Galvanized Coating

When the galvanized surface of a steel railing or inspector guard component is damaged or uncoated, the exposed steel shall be repaired if the cumulative total of the damaged and uncoated areas does not exceed 2% of the total area of each component or 0.02 m^2, whichever is less. Where the cumulative area exceeds these amounts, the damaged coating shall be stripped and the component re-galvanized according to ASTM A123/A123M.

Damaged and uncoated areas shall be cleaned of all rust and other contaminants and repaired using one of the following methods:

a) Soldering method using zinc-tin-copper solder

The surface preparation and application of flux and zinc-tin-copper solder shall be according to ASTM A780/A780M and the manufacturer's recommendations. The finished thickness of the metal coating in the repaired area shall be a minimum of 90 µm. The repaired surface shall be ground flush with the surrounding galvanized coating.

b) Thermal Metal Spraying

The surface preparation and application of thermal spray metal coating or metallizing shall be done according to SSPC-CS 23.00/AWS C2.23M/NACE No. 12 to provide a minimum thickness of 200 µm, applied in two separate coats.

The metal coating on the repaired areas shall have a minimum adhesion of 2.8 MPa, when tested according to ASTM D4541.

c) Zinc-Rich Touch-Up Paint

This method of repair of galvanized coating is permitted when:

i. The individual damaged and uncoated area is less than 625 mm^2, and

ii. The number of repair spots does not exceed 6 per each 12 m section of galvanized rail bar or inspector guard. The number of repair spots in each galvanized rail post shall be limited to a maximum of 2.

Two coats of one of the approved zinc-rich touch-up paint shall be brush applied after the surface preparation according to ASTM A780/A780M.

908.07.01.03 Aluminum Components

908.07.01.03.01 Fabrication

908.07.01.03.01.01 General

Welding of aluminum shall be permitted only where specified in the Working Drawings.

Fabrication and welding shall be according to CSA W59.2. All welding inspection shall be according to CSA W59.2.

Aluminum railings and posts shall be thoroughly cleaned of all discolorations by approved methods and all marks and scratches shall be removed. The railings, when erected, shall have a clean degreased aluminum surface of uniform appearance and texture.

Railing components shall be joined by riveting, bolting, expanding, or welding as specified in the Working Drawings. Special aluminum alloy fasteners shall only be used with written approval from the Contract Administrator.

When tubular balusters are fastened to the horizontal rails by expanding the tubes, the holes drilled into the rail shall not be more than 1 mm greater than the nominal diameter of the baluster tube. A standard self-feeding tapered roll expander shall be used to expand the balusters to allow for a tight fit in all rails.

Sheet or plate material may be sheared, sawn, or cut with a router; however, sheet or plate materials more than 10 mm thick shall only be sawn or routed. Cut edges shall be true and smooth, free from excessive burrs and ragged edges.

Re-entrant cuts shall only be used when unavoidable and, when they are used, a fillet shall be provided by drilling prior to cutting.

Aluminum alloys shall not be flame cut.

Boltholes in 10 mm or thinner material may be drilled or punched to finished size. In material thicker than 10 mm, the holes shall be drilled to finished size or sub-punched smaller than the nominal diameter of the fastener and reamed to size.

During fit-up, holes shall not be drifted in such a manner as to distort the metal, but holes misaligned less than 2 mm may be reamed to render a reasonable fit.

The shank of bolts shall be long enough to provide full bearing in the connection and, where the shank extends beyond the surface being clamped, washers shall be used under the nuts to ensure proper clamping.

908.07.01.03.02 Contact Surfaces

Where aluminum would otherwise come in contact with other metal surfaces, the contacting surfaces shall be separated from each other by use of a synthetic rubber or neoprene gasket. The single rail and double rail galvanized steel railings mounted on aluminum casting posts on top of a barrier wall or parapet wall are exempt from these requirements.

Where aluminum would otherwise come in contact with concrete, wood, or masonry, the contact surfaces shall be separated by means of a synthetic rubber or neoprene gasket or the aluminum surface shall be given a heavy coat of alkali-resistant bituminous paint prior to installation. The paint shall be applied as it is received from the manufacturer without the addition of thinner.

908.07.02 Anchorages

908.07.02.01 General

Anchorage assemblies shall be installed as specified in the Contract Documents.

908.07.02.02 Anchorages Installed Before Concrete Placement

When specified in the Contract Documents, anchorage components shall be installed prior to placing concrete and shall be securely tied to reinforcing bars. Anchorage assemblies shall be positioned with templates and installed securely in the formwork to maintain the position of the anchors during placement of concrete.

908.07.02.03 Anchorages Installed After Concrete Placement

Where anchors are to be installed in GFRP-reinforced concrete, anchors shall only be installed before concrete placement.

When specified in the Contract Documents, anchorages shall be installed after concrete placement. Holes shall be core drilled, anchoring grout placed, and anchors properly positioned at locations as specified in the Contract Documents. The placement of the anchoring agent and the anchors shall be according to the manufacturer's recommendations, except as modified in this clause. The holes shall be free of dust and debris immediately prior to placement of the anchoring agent. When the anchoring agent fails to fill the hole after insertion of the anchor, additional anchoring agent shall be immediately added to fill the hole.

When a cement based grout is used as the anchoring agent, the holes shall be pre-dampened for a period of one hour and any free water shall be removed prior to the application of the cement based grout.

When an epoxy grout is specified as the anchoring agent, the inside surface of the holes shall be roughened and dry prior to the application of the epoxy grout.

Where anchors are inserted into horizontal or inclined holes in a vertical face, the anchors shall be maintained in position during the setting of the anchoring agent. Loss of anchoring agent from the holes shall be prevented.

908.07.02.04 Anchorages Installed in Timber

Holes for bolts shall be drilled with a bit 1.5 mm larger in diameter than the bolt. The diameter of the recessed holes for the bolt heads shall be no greater than 10 mm larger than the width of the bolt head.

Where oil treatment has been used on the wooden curbing, the cut surfaces of the wood shall be given three coats of creosote oil. Each coat shall be allowed to dry before the next coat is applied.

Repairs to cuts in material treated with water-borne preservatives shall be according to CSA O80 Series.

908.07.03 Installation of Metal Railings and Inspector Guard

908.07.03.01 General

Metal railing and inspector guard shall be installed according to the Working Drawings.

Metal railing and inspector guard components shall be protected from damage and distortion during hot dip galvanizing, handling, transportation, storage, and installation.

Bedding grout shall not be used. Epoxy grout may be placed under post bases, as necessary, to fill the voids. The epoxy grout shall not have a thickness exceeding 3 mm. The surface preparation, mixing, installation, and curing time for the epoxy grout shall be according to the manufacturer's recommendations.

The work shall include installation of the anchorage assemblies installed after concrete placement or installed in wood.

908.07.03.02 Alignment

The metal railing and inspector guard shall be installed to the elevations and alignments as specified in the Contract Documents within a tolerance of ± 6 mm and with no kinks or other visible breaks in alignment throughout the length of the installation.

908.07.04 Quality Control

908.07.04.01 Inspection After Preparation of the Anchorages

A Request to Proceed shall be submitted to the Contract Administrator upon preparation of the anchorages and prior to the installation of the metal railing or inspector guard.

The installation of the metal railing or inspector guard shall not proceed until a Notice to Proceed has been received from the Contract Administrator.

908.07.04.02 Inspection After Installation of the Metal Railing or Inspector Guard

An inspection after installation shall be performed of the metal railing and/or inspector guard to ensure all the requirements are met as specified in the Working Drawings. The alignment of the metal railing or inspector guard shall remain within the tolerance limits after installation.

908.07.05 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

908.08 QUALITY ASSURANCE

908.08.01 General

Reasonable access shall be provided to the Owner to do inspection, testing, and sampling in the fabricating shop and field if requested to confirm that the materials supplied, the fabrication, and the installation have been completed as specified in the Contract Documents and Working Drawings.

908.09 MEASUREMENT FOR PAYMENT

908.09.01 Actual Measurement

908.09.01.01
Barrier Wall Railing
Parapet Wall Railing
Pedestrian Railing
Bicycle Railing
Combination Railing
Inspector Guard

Measurement of metal railings and inspector guard shall be by length in metres from end to end of the railing/inspector guard.

908.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

908.10 BASIS OF PAYMENT

908.10.01
Barrier Wall Railing - Item
Parapet Wall Railing - Item
Pedestrian Railing - Item
Bicycle Railing - Item
Combination Railing - Item
Inspector Guard - Item

Payment at the Contract price for the above tender items shall be full compensation for labour, Equipment, and Material to do the work.

MANUFACTURER'S CERTIFICATE OF CONFORMANCE

Contract Number: ……..……

Contractor: ……..……

Location / Structure: ……..……

Plant / Manufacturer: ……..……

Work, Component(s)/Element, or Product: ……
……
……

I, _____ (print name), P. Eng. _____ (Professional Engineers of Ontario License Number) certify that the above-noted part of work, component, or product have been constructed in general conformance to the requirements of the Contract Documents.

(Attach documents per Contract Documents (examples: test results, production records) outside of form)

Seal and Signature

_____
Date

DISTRIBUTION: 1) Contractor
2) Contract Administrator or Project Manager File

OPSF 906-1 (March 2021)

REQUEST TO PROCEED

Contract Number:		**Request to Proceed Number:**	
Contractor Name:		**Consultant Name:**	
Location / Structure Site:			
Description of the work:			
Work / Component(s) or Product:			
Applicable specification(s) /special provision(s):			

This is to confirm that the above stage of work, component or product has been completed according to the general requirements of the Contract Documents.

Submitted by: _____ Time & Date: _____
Contractor's Representative
(Printed Name and Signature)

Received by: _____ Time & Date: _____
Contract Administrator or Project Manager
(Printed Name and Signature)

DISTRIBUTION: 1) Contractor
2) Contract Administrator or Project Manager File

OPSF 906-2 (March 2021)

NOTICE TO PROCEED

Contract Number:		**Request to Proceed Number:**	
Contractor Name:		**Consultant Name:**	
Location / Structure Site:			
Description of the work:			
Work / Component(s) or Product:			
Applicable specification(s) /special provision(s):			

The Contractor may proceed to the next operation as of the date of this notice.

Any Notice to Proceed by the Owner or its Contract Administrator or Project manager of the Work and Materials of the Contractor does not relieve the Contractor from any responsibility or obligation for the proper performance of the Work in general conformity with the requirements of the Contract Documents. As well, the Notice to Proceed imposes no liability upon the Owner or its Contract Administrator or Project Manager and is not to be interpreted as an approval or acceptance of the Work or the Materials by the Owner that the Work and Materials was completed or supplied in general conformance with the Contract Documents.

Issued by: _____ Time & Date: _____
Contract Administrator or Project Manager
(Printed Name and signature)

Received by: _____ Time & Date: _____
Contractor's Representative
(Printed Name and signature)

DISTRIBUTION: 1) Contractor
2) Contract Administrator or Project Manager File

OPSF 906-3 (March 2021)

Appendix 908-A, November 2022
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The design should specify the following in the Contract Documents:

- Steel Grade of rails and posts. (908.05.01.01)

- Grade of steel plate. (908.05.01.01, 908.05.02)

- Paint for steel railing and steel posts. (908.05.01.01)

- Requirements for galvanized bolts and nuts. (908.05.01.01, 908.05.02)

- Coating requirements for the inspector guard. (908.05.02)

- Anchorage assembly requirements. (908.05.03)

- Grout requirements. (908.05.04)

- Anchorage assembly installation. (908.07.02.01)

- Metal railing and inspector guard installed elevations and alignments (908.07.03.02)

- Management of excess material. (908.07.05)

The design should determine if the following are required and, if so, specify them in the Contract Documents:

- Anchorage to be installed prior to concrete placement. (908.07.02.02)

- Anchorage to be installed after concrete placement. (908.07.03.03)

Clause 908.07.04.01 requires the use of OPSF 906-2 as a Request to Proceed and OPSF 906-3 as a Notice to Proceed. Clause 908.04.01.02 requires the use of OPSF 906-1 as a Manufacturer's Certificate of Conformance, OPSF 906-2 as a Request to Proceed, and OPSF 906-3 as a Notice to Proceed. If any form(s) other than OPSF 906-1, OPSF 906-2, or OPSF 906-3 will be used for submission purposes, the alternate form(s) should be invoked by reference in the Contract Documents and the specification should be amended to remove reference to the OPSF(s).

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 3419.100	Barriers and Railings, Steel Beam, Guide Rail and Channel Anchorage
OPSD 3419.150	Barriers and Railings, Steel, Single Railing Anchorage
OPSD 3419.155	Barriers and Railings, Steel, Double Railing Anchorage

CONSTRUCTION SPECIFICATION FOR PRESTRESSED CONCRETE - PRECAST MEMBERS

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909-A **Commentary**

909.01 SCOPE

This specification covers the construction requirements for fabrication, delivery, and installation of precast prestressed concrete members with steel reinforcement.

909.01.01 Specification Significance and Use

This specification has been developed for use in municipal oriented Contracts. The administration, testing, and payment policies, procedures, and practices reflected in this specification correspond to those used by many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

909.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

909.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 904	Concrete Structures
OPSS 905	Steel Reinforcement for Concrete
OPSS 910	Stressing Systems for Post Tensioning
OPSS 919	Formwork and Falsework
OPSS 929	Abrasive Blast Cleaning - Concrete Construction

Ontario Provincial Standard Specifications, Material

OPSS 1002	Aggregates - Concrete
OPSS 1213	Hot Applied Rubberized Asphalt Waterproofing Membrane
OPSS 1350	Concrete - Materials and Production
OPSS 1440	Steel Reinforcement for Concrete
OPSS 1442	Epoxy Coated Steel Reinforcement for Concrete

Ontario Ministry of Transportation Publications

MTO Laboratory Testing Manual:

LS-407	Method of Test for Compressive Strength of Moulded Cylinders
LS-426	Method of Test for Compressive Strength of High Performance Concrete Cylinders
LS-432	Method of Test for Microscopical Determination of Air Void System Parameters in Hardened Concrete
LS-433	Method of Test for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration

Structural Manual

CSA Standards

A23.2-3C	Making and Curing Concrete Compression and Flexural Test Specimens*
A23.2-1D	Moulds for Forming Concrete Test Cylinders Vertically *
A23.4-16 (R2021)	Precast Concrete - Materials and Construction
G40.20-13/G40.21-13 (R2018)	General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel
G164-18	Hot Dip Galvanizing of Irregularly Shape Articles
G189-1966 (R2003)	Sprayed Metal Coatings for Atmospheric Corrosion Protection
S6:19	Canadian Highway Bridge Design Code
W47.1-09 (R2014)	Certification of Companies for Fusion Welding of Steel Structures
W59-18	Welded Steel Construction (Metal Arc Welding)
W186-M1990 (R2016)	Welding of Reinforcing Bars in Reinforced Concrete Construction
	*[Part of A23.1-09/A23.2-09 - Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete]

ASTM International

B633-19 Electrodeposited Coatings of Zinc on Iron and Steel
C171-20 Sheet Materials for Curing Concrete

American Association of State and Highway Transportation Officials (AASHTO)

M182-05 (2017) Burlap Cloth made from Jute or Kenaf and Cotton Mats

909.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Bed means the assembly consisting of platform, forms and end blocks in which the members are cast.

Certificate of Conformance means a form issued by an Engineer confirming that the specified components of the Work are in general conformance with the Contract Documents as shown in OPSF 539-1.

Concrete Construction Report means a form used by the Contractor to report concrete test information as shown in OPSF 909-1.

Design Proposal means a submission of proposed changes when engineering design is required.

Laitance means a layer of weak and nondurable material on the surface of the concrete containing cement and fines from aggregates, brought by bleeding water to the top surface concrete.

Lot means all the members of the same member type, cast during 7 consecutive Days.

Manufacturer's Certificate of Conformance means a letter issued by an Engineer confirming that the fabrication and required testing has been carried out on a component or product in general conformance with the Contract Documents as shown in OPSF 906-1.

Member means a precast concrete prestressed girder.

Member Type means a member differentiated by its cross-section shape such as box, I, or T.

Notice to Proceed means a form issued by the Contract Administrator notifying the Contractor to proceed to the next operation as shown in OPSF 906-3.

Post-Tensioning means a method of prestressing in which tendons are tensioned after the concrete has reached a predetermined strength.

Precaster means the party who produces the members.

Prestressed Concrete means reinforced concrete in which internal stresses have been initially introduced so that subsequent stresses resulting from dead load and superimposed loads are counteracted to a desired degree. This may be accomplished by pretensioning or post-tensioning.

Pretensioning means a method of prestressing in which tendons are tensioned before the concrete is placed.

Repair Proposal means a submission when repairs to the members are required.

Request to Proceed means a form issued by the Contractor notifying the Contract Administrator that a component or stage of the work has been completed in general conformance with the Contract Documents. Form is OPSF 906-2.

Strand means a group of wires laid helically over a central core-wire.

Sweep means the lateral deviation from straightness of a member with respect to its design centre line.

Tendon means a high strength steel element consisting of one or more wires, strands or bars; used to impart prestress to the concrete.

909.04 DESIGN AND SUBMISSION REQUIREMENTS

909.04.01 Design Requirements

909.04.01.01 General

The design shall be according to CAN/CSA S6 and the Structural Manual.

909.04.01.02 Permissible Changes from the Contract Drawings

909.04.01.02.01 General

Changes from the Contract Drawings are permitted and may be implemented by the precaster, without prior approval from the Owner, provided they meet the requirements of this specification.

909.04.01.02.02 Permissible Changes to Prestressing of Members

The prestressing strand pattern may be adjusted to suit production requirements provided all changes meet the original design strength without adversely affecting other components of the structure. If the centre of gravity of the strands at the interior hold down closest to mid-span is within $\pm$ 10 mm of the original design, then one or more of the following adjustments shall be permitted provided that both the serviceability and ultimate limit states capacities are not adversely affected:

a) Provide additional strands with a lower jacking stress provided the total prestress force is within $\pm$ 2% of the original design.

b) Use of imperial strand spacing in lieu of metric, where 25 mm = 1” and 50 mm = 2”.

c) Addition of one hold-down per end is added towards the member end at the same spacing as the original design.

d) One less hold-down per end when the hold-down closest to mid-span is deleted.

e) Increase or decrease the number of strands in each hold-down group.

f) Increase of vertical strand spacing between hold-down points from 25 mm up to 50 mm.

909.04.01.02.03 Permissible Changes to Reinforcing of Members

The stirrup projection may be adjusted from that shown on the original design, based on details such as the predicted camber, provided it meets the deck embedment range indicated elsewhere in the Contract Documents.

Spacing of stirrups around blockouts for diaphragms may be adjusted, as long as the minimum spacing requirements of CAN/CSA S6 are satisfied, and up to two stirrups may be added in order to maintain the total reinforcement requirements.

909.04.01.02.04 Other Design Details

Details limited to those below may be adjusted to suit production requirements, provided all changes meet the original design without adversely affecting other components of the structure:

a) Dowel holes and inserts may be adjusted vertically within $\pm$ 75 mm from the location shown on the original design to avoid any conflict with tendons.

b) Undercut dimensions may be adjusted to accommodate the predicted camber.

c) Additional pockets and hardware for temporary bracing may be added.

d) Additional temporary post-tensioning or pre-tensioning for shipping and handling may be added provided they do not adversely affect the members at any stage.

The production length of the member may be adjusted to account for elastic shortening.

909.04.01.03 Temporary Bracing

Temporary bracing for members shall be designed according to CAN/CSA S6 using a wind load specific for the location and having a return period of 10 years if the members are to be permanently connected within the same construction season. If the members are not to be permanently connected within the same construction season, the return period to be used in the design shall be 25 years.

909.04.02 Submission Requirements

909.04.02.01 Working Drawings

Three sets of Working Drawings, including supporting documentation, shall be submitted to the Contract Administrator at least 7 Days prior to commencement of fabrication of the members, for information purposes only. Prior to making a submission, the design Engineer and the design-checking Engineer shall affix their seals and signatures on the Working Drawings verifying that the drawings are consistent with the Contract Documents.

When other authorities are involved in the approval of the design or construction of a highway structure, submissions shall be made at least 5 weeks prior to commencement of work and one additional copy of the submission shall be provided for each authority. The requirements of each authority and the Owner, as specified in the Contract Documents, shall be satisfied prior to commencement of the Work.

The Working Drawings shall include the following information:

a) Member details.

b) Prestressing reinforcing steel size, grade, location, and jacking force as required by the design.

c) Hold-down locations and forces.

d) Reinforcing steel schedules.

e) Lifting point locations.

f) Details and location of all temporary supports.

g) All other applicable details.

The supporting documents shall include the following information:

a) A letter signed and sealed by an Engineer listing all permitted changes made along with supporting calculations. The letter shall state that the changes have not adversely affected the member capacities.

b) Handling and installation procedures, including calculations and lifting point locations.

c) Details of bracing installed to provide adequate support and stability to the member during construction.

909.04.02.02 Concrete Mix Design

The concrete mix design shall be according to OPSS 1350 and shall be submitted to the Contract Administrator.

909.04.02.03 Concrete Plant Certification

The precast concrete plant certificate verifying compliance with the certification requirements of the Canadian Standards Association (CSA) under the category Precast Concrete Products-Structural, Prestressed; or by the Canadian Precast Concrete Quality Assurance Certification Program (CPCQA), Group B, Category D, shall be submitted to the Contract Administrator as part of the concrete mix design submission.

Documentation verifying certification of the concrete production facility by the Ready-Mixed Concrete Association of Ontario shall be submitted when concrete is supplied by an external concrete supplier.

909.04.02.04 Control of Concrete Temperature

One week prior to the commencement of fabricating the members, a description of the method for monitoring and effectively controlling the temperature of the concrete shall be submitted to the Contract Administrator, for information purposes only. The description shall include the method of controlling the concrete temperature during the curing and protection period.

909.04.02.05 Manufacturer's Certificate of Conformance and Precast Report

A Manufacturer's Certificate of Conformance and a precast report shall be submitted to the Contract Administrator for each shipment of members at least 5 Business Days prior to shipping from the precasting plant.

The precast report shall contain the following information:

a) List of members in the shipment, including their ID number and description.

b) The mill certificates for the strands, along with the elongation calculations based on the actual material properties specified in the mill certificate of the strands used in the work.

c) Record of the jacking force, elongations, and corrections used for temperature variation.

d) Temperature control records, including location of thermocouple wires.

e) Summary of material test results for plastic concrete: air content, slump, and concrete temperature.

f) Summary of material test results for hardened concrete: transfer strength, confirmation of the projected 28-Day compressive strength, and air void system parameters. If test results are not available at the time of shipping, they may be submitted within 4 Business Days following completion of testing.

g) Summary of all measurements and inspections required herein, including the concrete cover, crack measurement summary, tolerances, and surveys for geometric control.

h) Documentation that all repairable defects have been identified, evaluated, and corrected, as detailed under the clause on Repair of Defects and Deficiencies Repairable by Standard Methods.

A Request to Proceed shall be submitted to the Contract Administrator before the delivery of each shipment of members to the site.

The members shall not be delivered to the site until the Contract Administrator has received the Manufacturer's Certificate of Conformance, the precast report, Request to Proceed, and issued a Notice to Proceed.

909.04.02.06 Design Proposals

Five copies of the design proposal shall be submitted to the Contract Administrator for acceptance. The design proposals shall bear the seal and signature of the design Engineer and the design checking Engineer. The proposed changes shall not proceed until the design proposal has been accepted by the Contract Administrator.

The Contract Administrator shall respond within ten Business Days of receiving the design proposal.

909.05 MATERIALS

909.05.01 Bearing Plate

The bearing plate shall be according to CSA G40.20/G40.21, Grade 300W or greater.

Anchor studs shall be a headed type and shall be according to CSA W59. Anchor studs shall be welded to the bearing plates prior to galvanizing.

All surfaces shall be hot dipped galvanized and shall be according to CAN/CSA G164 or shall be zinc metallised and shall be according to CSA G189.

909.05.02 Burlap

Burlap shall be according to AASHTO M182, Class 4, and shall be free from substances that are deleterious to concrete. The burlap shall have no tears or holes.

909.05.03 Concrete

Concrete materials and production shall be according to OPSS 1350 with the following exceptions and amendments:

a) Compressive strength shall be as specified in the Contract Documents.

b) The air void system in hardened concrete when tested according to LS-432 shall be:
   i. Air Content: 3.0% minimum
   ii. Spacing Factor: 0.200 mm maximum

c) Rapid chloride permeability of concrete containing silica fume at 28 to 32 Days shall be equal to or less than 1,000 coulombs and rapid chloride permeability of all other concrete at 28 Days shall be equal to or less than 2,500 coulombs.

d) Aggregates shall be according to OPSS 1002 with the exception that the maximum nominal size of coarse aggregate shall not exceed 19.0 mm.

e) Slag aggregate shall not be used.

f) Superplasticizer may be added to the mix at time of batching for all types of concrete.

909.05.04 Concrete Sealers

Concrete sealers shall be from the Owner's list of acceptable sealers.

909.05.05 Elastomeric Coating

Elastomeric coating shall be according to OPSS 1213.

909.05.06 Formwork

All formwork shall be according to OPSS 919 and CAN/CSA A23.4. Forms shall be fabricated to meet the dimensional tolerances and finishes required herein.

909.05.07 Hardware

All hardware shall be non-corroding or be galvanized according to CAN/CSA G164.

The hold down device may be black steel, however, the surfaces of the hold down device located within 40 mm of the concrete surface shall be chromate coated over an electrodeposited coating of zinc according to ASTM B633.

909.05.08 Moisture Vapour Barrier

The moisture vapour barrier shall be a white opaque polyethylene film according to ASTM C171 and shall not be less than 100 µm thick.

909.05.09 Post-Tensioning Material

Post-tensioning material, including grout shall be according to OPSS 910.

909.05.10 Proprietary Patching Materials

Proprietary patching materials shall be from the Owner's pre-qualified list of concrete patching materials. The list of proprietary patching material shall be obtained from the Contract Administrator.

909.05.11 Steel Reinforcement

Steel reinforcement shall be according to OPSS 905, OPSS 1440, and OPSS 1442.

909.05.12 Strand Splices

Strands shall not be spliced.

909.06 EQUIPMENT

909.06.01 Chipping Hammers

Chipping hammers shall have a maximum weight of 9.0 kg and a maximum piston stroke of 102 mm. All hammers shall have the manufacturer's name and model number engraved on them by the manufacturer. All information must be legible.

909.06.02 Pretensioning and Post-Tensioning

Pretensioning equipment shall be according to CSA A23.4. Post-tensioning equipment shall be according to OPSS 910.

909.06.03 Thermocouples and Dataloggers

Thermocouples and associated instrumentation shall have an accuracy of $\pm$ 1.5 °C and shall be capable of recording temperature and instantaneously displaying the temperature.

909.07 CONSTRUCTION

909.07.01 General

The Contract Administrator shall be notified in writing at least 7 Days prior to commencement of fabrication.

Each member shall be identified with a unique number and the date of casting. The information shall be marked on the members and shall remain visible for the duration of construction. When the information is stencilled, indelible ink or paint shall be used.

909.07.02 Precast Plant Certification

Members shall be fabricated by a plant certified by the Canadian Standards Association (CSA) under the category Precast Concrete Products-Structural, Prestressed; or by the Canadian Precast Concrete Quality Assurance Certification Program (CPCQA), Group B, Category D.

909.07.03 Pretensioning

Tendons shall not be tensioned in the deflected position, unless the hold-down device used permits free movement of the strand and the use of the device has been tested by its manufacturer to ensure that the final stress along the full length of the tendon is uniform.

909.07.04 Welding

Welding of steel hardware including shear studs shall be according to CSA W59 and shall be performed by a qualified welder working for a company certified by the Canadian Welding Bureau according to CSA W47.1.

Welding of reinforcing steel bars shall be according to CSA W186 and performed by a qualified welder working for a company certified by the Canadian Welding Bureau according to CSA W186.

909.07.05 Steel Reinforcement

The placement of steel reinforcement shall be according to OPSS 905, with the exception or addition or both of the placing tolerances listed below:

a) Vertical position of prestressing tendons: + 5/-10 mm

b) Length of debond on prestressing tendons: ± 50 mm

c) Projection of positive moment connection reinforcing steel at member ends: ± 25 mm

d) Stirrup spacing: ± 15 mm when spacing is 100 mm or less
± 25 mm when spacing is greater than 100 mm
± 30 mm when spacing is 300 mm or greater

909.07.06 Formwork

Formwork shall be according to OPSS 919.

909.07.07 Placing of Sheaths and Anchorages

When members are to be post-tensioned, the sheaths and anchorages shall be placed according to OPSS 905 except that the placing tolerances shall be ± 5 mm at splice points and ± 10 mm elsewhere.

909.07.08 Placing Concrete

The temperature of formwork, steel reinforcement, or the material on which the concrete is to be placed shall not exceed 30 °C.

The placing of concrete shall be according to OPSS 904, with the exception that the temperature of the formwork, steel reinforcement, or the material on which the concrete is to be placed shall be at a minimum temperature of 5 °C, prior to the placing operation. After discharging of concrete has started, one addition of superplasticizer shall be allowed, provided there is sufficient remaining time for mixing and testing. The slump and air content shall be re-tested if the mix is re-dosed.

During the placing operation, all exposed concrete surfaces shall be covered with water saturated burlap, within 2 to 4 m of the concrete reaching the top of the forms.

909.07.09 Concrete Finishing

The top surface of prestressed members, against which new concrete is to be placed, shall be intentionally roughened while it is sufficiently plastic so that the depth of the indentations is at least 5 mm and the spacing is not greater than 15 mm.

All concrete surfaces against which new concrete is to be placed shall be clean, sound, and free from any loose particles and laitance.

The following surfaces shall be abrasive blast cleaned according to OPSS 929, prior to shipping the members:

a) Top portion of members containing laitance.

b) The portion of the sides and end of the member against which new concrete is to be placed.

909.07.10 Control of Temperature

During production and during moist curing, moisture retention, and protection periods, the following temperature requirements shall be met:

a) The concrete temperature shall not exceed 70 °C.

b) The concrete temperature shall not fall below 10 °C before the concrete has reached 75% of the specified 28-Day compressive strength.

c) The temperature difference between the concrete temperature of the member, and the conditions to which it is to be exposed shall not exceed 20 °C along any part of the member.

909.07.10.01 Temperature Records

Thermocouples, data loggers, handhelds units, and associated hardware shall be used to monitor the temperature of the member and the ambient conditions to which the member is exposed.

A sufficient number of thermocouples and thermocouple wires shall be installed to ensure compliance with the standard. As a minimum, thermocouples shall be installed to measure the following:

a) Air temperature that the member is exposed or is to be exposed to.

b) Concrete temperatures at the following locations:

For I-members
i. In the middle of the web, 1 m from each end of the member.
ii. In the middle of the web at mid-span.
iii. In the middle of the bottom flange at mid-span.

For box-members
i. In the middle of the solid section at each end of the member.
ii. In the middle of the bottom slab at mid-span.

Recording of the concrete temperatures shall begin at the start of the placing operation and continue until the moist curing, moisture retention, and protection periods are complete. For each member, the listed temperatures shall be recorded at intervals of 30 minutes or less.

The Contract Administrator shall be provided with necessary access, instrumentation, and equipment to verify temperature readings instantaneously. The thermocouples and data loggers shall be left in place until the end of the monitoring period.

909.07.11 Curing and Protection

909.07.11.01 Curing - General

Moist curing shall be applied for 48 hours followed by a 48-hour moisture retention period.

Concrete containing silica fume shall be moist cured for 7 Days, regardless of the ambient conditions.

During the moist curing and moisture retention period, the members may be exposed to ambient conditions for no more than a cumulative total of 3 hours for the purposes of form removal, release of strands at transfer strength, filling of bug holes, inspection, removal from the bed, and storage.

909.07.11.02 Moist Curing

During the first 48 hours after concrete placement, exposed surfaces shall be moist cured by any of the methods described below.

a) Saturated burlap.

b) Water spray or misting.

c) Steam.

d) Other means of maintaining 100% relative humidity next to the concrete surface.

Surfaces covered by the forms are not considered exposed. If forms are removed within the first 48 hours, all concrete surfaces shall be immediately moist cured by the positive addition of moisture for the duration of the 48 hours, according to the methods noted above.

Spray or steam to raise the ambient temperature above 30 °C, shall not be applied until after the concrete has attained its initial set. Steam, heat, or forced air shall not be directed on the concrete, forms, reinforcing steel or tendons. There shall be free circulation of steam, heat, and forced air around the top, sides, and ends of the members. The members shall be heated evenly. Concrete surfaces shall not be exposed to combustion gases.

All water shall be removed from and precautions taken to prevent the re-entrance of water into the sheaths or any internal voids.

909.07.11.03 Moisture Retention

After the initial moist curing has been completed, member surfaces shall be completely covered by moisture vapour barrier to protect members from moisture loss for a period of 48 hours. Alternatively, moist curing methods may be continued during this period.

909.07.11.04 Protection from Cold

Prior to full exposure and after the moist curing and moisture retention periods, members that are to be exposed to temperatures less than 5 °C shall be protected from moisture loss for a minimum of an additional 3 Days. The protection period shall be extended beyond 3 Days, if required to meet the Control of Temperature clause.

All members must be dry prior to exposing them to temperatures below 0 °C.

909.07.12 Transfer of Prestressing Force

The prestressing force shall not be transferred to the members until the transfer strength specified in the Contract Documents has been reached. The prestressing force shall be transferred gradually and in a sequence that ensures eccentricities are kept to a minimum.

909.07.13 Treatment at Ends of Members

The prestressing tendons at ends of members that are to be encased in concrete shall be cut off 25 mm beyond the ends of the beams. The prestressing tendons at the end of members that are not to be encased in concrete shall be cut back to recess the cable 25 mm from the end of member. The recess shall be cleaned, filled with a proprietary patching material, and the ends of the members coated with elastomeric coating.

909.07.14 Quality Control

909.07.14.01 General

Sufficient quality control testing and inspection shall be carried out to ensure that the concrete meets the requirements of the Contract Documents.

909.07.14.02 Sampling and Testing of Plastic Concrete

All aspects of sampling and testing of the plastic concrete for slump, air content, and temperature shall be according to OPSS 1350. The results of these tests shall be recorded. The minimum frequency of testing shall be at least once for each load of concrete delivered by a truck mixer, or once for every 7 m^3 of concrete for non-truck mixers until satisfactory control is established.

Satisfactory control is established when three consecutive tests of concrete are within the specified requirements, without field adjustments. If any field adjustments are required, testing shall continue until three consecutive tests meet the requirements with no field adjustments.

After satisfactory control has been established, testing shall be carried out on every third load delivered by a truck mixer, or at a delivery frequency of 21 m^3 of concrete for non-truck mixers.

Sampling and testing of slump, air content, and temperature of plastic concrete, and casting of cylinders for determination of hardened concrete properties shall be carried out by a person holding either of the following certifications:

a) CCIL Certified Concrete Testing Technician

b) ACI Concrete Field Testing Technician, Grade 1

The person shall have a valid original card issued by the certifying agency in their possession at all times.

909.07.14.03 Transfer Strength

It shall be demonstrated that the transfer strength specified in the Contract Documents has been achieved prior to transfer of prestressing force.

Standard cylinder correlation strength testing programs shall be conducted by the Ministry of Transportation when requested by the Owner.

909.07.14.04 Concrete Cover Measurement

A cover meter survey on all members shall be carried out at the precaster's facility until satisfactory control is established. For each lot, satisfactory control shall be established when three consecutive members of the same design are within the specified tolerances. After satisfactory control has been established, testing shall be carried out on every fifth member. If testing indicates that cover measurements for a member do not meet the tolerances specified in Table 1, testing shall resume on each member until satisfactory control is re-established.

Readings shall be taken at locations 300 mm from both ends, at mid-span, and at intervals not exceeding 5 metres along the length of the member.

For I-members, readings shall be taken at each location, as detailed below:

a) Top of web, both sides.

b) Bottom of web, both sides.

c) Mid-height of each side of bottom flange.

d) Underside of member, located at 150 mm from both edges of flange.

For box members, readings shall be taken at each location, as detailed below:

a) Top of web, exterior sides.

b) Bottom of web, exterior sides.

c) Underside of member, located at 400 mm from both edges of flange.

909.07.14.05 Dimensional Measurements

Measurements shall be carried out on each member to determine compliance with tolerance requirements. Members shall meet the tolerances specified in Table 1.

909.07.15 Sampling for Quality Assurance

Concrete shall be sampled on a lot basis.

909.07.15.01 General

Cylinders shall be 100 mm in diameter and 200 mm long. Samples shall be taken after all field adjustments have been made to the load of concrete.

Concrete cylinders shall be cast, cured, handled and transported according to CSA A23.2-3C. The specimens shall be delivered to a CCIL-approved laboratory as designated by the Contract Administrator.

Moulds shall be according to CSA A23.2-1D, with a lid. The lids shall be chemically and physically compatible with the concrete and shall provide a watertight seal for the moulds.

909.07.15.02 28-Day Compressive Strength

One set shall be cast for acceptance and one set of referee cylinders may be cast for each lot. Both sets of cylinders shall be cast from the same batch of concrete.

One set shall consist of three cylinders.

Test information shall be recorded on OPSF 909-1. The form shall be submitted with the concrete cylinders.

909.07.15.03 Air Void System and Rapid Chloride Permeability

One cylinder shall be cast from each lot for determination of air void system parameters of hardened concrete and two cylinders from each lot for determination of rapid chloride permeability. Each cylinder shall be cast from concrete from a different member in the lot.

909.07.15.04 Sampling of Steel Reinforcement

Samplings of steel reinforcement shall be provided to the Owner according to OPSS 905 when requested.

909.07.16 Access for Quality Assurance

Electrical power, scaffolding, protection from the weather, and unhindered access shall be provided to Owner's representatives for inspection and testing of all fabrication, delivery, and installation of prestressed concrete precast members.

For the purposes of cover meter and dimensional measurements, all debris and obstructions shall be cleared and the Owner's representative shall be provided access.

909.07.17 Delivery

The Contract Administrator shall be notified in writing 3 Days prior to delivery of the members.

Delivery shall include transportation and storage of the members. Transportation and storage shall be according to CAN/CSA A23.4. The work shall consist of loading of the members, delivery, unloading, and storage at the storage site and shall include temporary works for access.

Members shall be loaded for shipping in such a manner that they can be transported and unloaded at their destination without being damaged or exposed to stresses for which they were not designed.

Members shall be handled and transported with their webs in a vertical plane, and the points of support during lifting, storing, and transporting shall be according to the Working Drawings. When stored, members shall be stored in such a manner to avoid excessive stress or other damage.

Advertising by means of removable signing is permitted on elements only while in transit to the storage site. Any permanent markings on a surface that would be visible after installation shall not be permitted.

909.07.18 Installation

The Contract Administrator shall be notified in writing of the installation date at least 3 Days prior to the commencement of field installation operations. Installation shall be according to CAN/CSA A23.4.

The work shall consist of installation and stabilization of the members during construction. Members shall be lifted and placed in a manner to ensure they are not overstressed, unstable, or unsafe at any time.

A copy of the Working Drawings shall be kept on the site and accessible to the Contract Administrator during installation of the members.

The installation tolerance of members shall be $\pm$ 15 mm on the bearing in both the longitudinal and transverse directions.

For box members placed side-by-side, accumulated tolerance differences shall be distributed equally along the width of the structure. The maximum accumulated increase or decrease in total width of the members shall not exceed 70 mm with 35 mm maximum on either side.

The forces resulting from the lifting devices acting on the members shall not be inclined to the vertical at an angle greater than 30 degrees. All lifting devices for members shall be removed prior to the deck being poured.

CPCI members and other members that may experience stability problems during construction shall be braced individually by attaching each end to the respective substructure element, immediately upon installation.

909.07.19 Repair of Defects and Deficiencies Repairable by Standard Methods

Any individual member having one or more of the defects and deficiencies identified in Table 2, shall be repaired according to the repair method specified. Such repairs do not require proposals or owner approval. Where more than one of the defects or deficiencies listed in Table 2 are located in the same area in the member, a repair proposal shall be submitted. All causes, preventative actions, and corrective actions, including repair methods and materials used shall be documented.

909.07.19.01 Assessment of Repair

When defects or deficiencies occur, at the discretion of the design Engineer, a visual inspection may be conducted or other measures required, such as cores to be taken to assess the effectiveness of the repairs.

The filling of core holes shall be according to OPSS 1350.

909.07.20 Certificate of Conformance

A Certificate of Conformance shall be submitted to the Contract Administrator within 5 Business Days of installing all the members within a stage. The Certificate of Conformance shall identify the members and state that the Work has been carried out in general conformance with the signed and sealed documents, which include the Working Drawings, supporting documents, and Contract Documents.

909.07.21 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

909.08 QUALITY ASSURANCE

909.08.01 General

The acceptance of members shall be according to the requirements of this specification, including satisfactory completion of all repairs, if applicable. Members not meeting the requirements of the Contract Documents shall be deemed unacceptable and shall not be included in the Work.

909.08.02 Acceptance of Concrete Compressive Strength

A 28-Day concrete compressive strength of a lot shall be considered acceptable when it meets all of the following:

a) The average of the three individual compressive strength tests shall be equal to or greater than the specified strength.

b) No individual cylinder test shall be more than 4.0 MPa below the specified strength.

Unacceptable lots shall be removed and replaced.

Compressive strength shall be determined according LS-426 for concrete with silica fume and high strength concrete and according to LS-407 for all other concrete.

The compressive strength result of the lot shall be the average of the set of three acceptance cylinders rounded to one decimal place.

The individual test results shall be forwarded to the Contractor as they become available.

909.08.02.01 Referee Testing Compressive Strength

If the Contractor has submitted a set of referee cylinders, an individual test result may be questioned by the Contractor within 4 Business Days of receiving the test result. The Owner shall be notified of the intention to referee test.

The lot shall be re-evaluated as based on the test result from the referee compressive strength cylinders representing the lot and the referee test result shall replace the original test result. The referee test result shall be binding.

909.08.03 Acceptance of Air Void System in Hardened Concrete

One half of a cylinder shall be tested to determine the acceptability of the lot. The cylinder shall be tested according to LS-432. The other half of the cylinder shall be retained by the Owner for audit purposes.

Individual test results shall be forwarded to the Contractor, as they become available.

For a lot to be considered acceptable, the cylinder shall have an air content of 3.0% or more and a spacing factor of 0.200 mm or less. Acceptable lots shall be subject to full payment.

Lots with a spacing factor between 0.200 mm and 0.250 mm shall be repaired as identified in Table 2.

Lots with a spacing factor exceeding 0.250 mm shall be rejected and replaced at the Contractor's expense.

909.08.03.01 Referee Testing of Air Void System in Hardened Concrete

Referee testing of air void system parameters shall be according to OPSS 1350.

909.08.04 Acceptance of Rapid Chloride Permeability

Rapid chloride permeability testing shall be according to LS-433. Acceptance of rapid chloride permeability shall be based on the result obtained on the cylinders representing the lot. Lots with rapid chloride permeability less than 2,500 coulombs are considered acceptable. Lots with a rapid chloride permeability result greater than 2,500 coulombs and less than or equal to 3,500 coulombs shall be considered unacceptable and shall be repaired as identified in Table 2. Lots with rapid chloride permeability results exceeding 3,500 coulombs shall be rejected and replaced.

For concrete lots containing silica fume, rapid chloride permeability less than 1,000 coulombs are considered acceptable. Lots containing silica fume with a rapid chloride permeability result greater than 1,000 coulombs and less than or equal to 2,000 coulombs shall be considered unacceptable and shall be repaired as identified in Table 2. Lots containing silica fume with rapid chloride permeability results exceeding 2,000 coulombs shall be rejected and replaced.

909.08.04.01 Referee Testing of Rapid Chloride Permeability

Referee testing of rapid chloride permeability testing for all concrete shall be carried out according to the high performance concrete requirements of the OPSS 1350 Acceptance of Rapid Chloride Permeability for Silica Fume Overlays and High Performance Concrete clause. The reference to cores in OPSS 1350 shall be interpreted to mean cylinders.

909.08.04.02 Referee Testing Cost of Rapid Chloride Permeability

The cost of rapid chloride permeability testing for all concrete shall be according to OPSS 1350 Acceptance of Rapid Chloride Permeability for Silica Fume Overlays and High Performance Concrete clause.

909.08.05 Dimensional Verification and Concrete Cover Measurements

The Contract Administrator shall carry out measurements to confirm compliance with tolerance requirements of Table 1. Members exceeding the tolerances specified in Table 1 shall be rejected and not incorporated into the Work.

909.08.06 Defects and Deficiencies

909.08.06.01 General

Defects and deficiencies are classified as follows:

a) Defects and deficiencies repairable by standard methods.

b) Defects and deficiencies causing rejection.

c) All other defects and deficiencies.

909.08.06.02 Defects and Deficiencies Repairable by Standard Methods

Any individual member having one or more of the defects and deficiencies listed in Table 2 shall be deemed unacceptable and the member shall be repaired according to Table 2. When more than one of the defects or deficiencies listed in Table 2 is located in the same area in the member, a proposal for repair shall be submitted to the Contract Administrator for acceptance according to the All Other Defects and Deficiencies clause.

909.08.06.03 Defects and Deficiencies Causing Rejection

A member having any one of the following defects and deficiencies shall be rejected and shall not be incorporated into the Work:

a) If concrete temperature exceeds 70 °C at any time during the curing period.

b) For I-members, if there is honeycombing, voids, cavities, spalls, delaminations, or cracks, in the concrete within a bearing surface area defined by the contact area of the bearing plus 30 mm on all sides, except when member ends are encased in concrete.

c) For box members, if there is honeycombing, voids, cavities, spalls or delaminations in the concrete within a bearing surface area defined by the contact area of the bearing plus 30 mm on all sides, except when member ends are encased in concrete.

d) If there is a crack in the bottom flange that extends through to the opposite face.

e) If breakage of strand wires exceeds the limit permitted according to CAN/CSA A23.4.

f) If the sweep of the member on site and in position without any intermediate bracing is in excess of 1.5 mm/m length of member.

909.08.06.04 All Other Defects and Deficiencies

For members with defects or deficiencies that are not identified as rejectable or included in the list of defects and deficiencies repairable by standards methods in Table 2, or when more than one of the defects or deficiencies listed in Table 2 are located in the same area in the member, a proposal for repair shall be submitted to the Contract Administrator for acceptance.

If the repair proposal is deemed acceptable, the members shall be repaired according to the proposal. No repairs shall be carried out without the acceptance of the proposal. If the repair proposal is deemed unacceptable, the members shall be rejected and shall not be incorporated into the Work.

The repair proposal, signed and sealed by an Engineer, shall include as a minimum:

a) Description of the member and identification of the defects or deficiencies.

b) Detailed sketches, width, length, depths, location, and nature and frequency of any defects.

c) Assessment of any impact of the repaired defects on durability, structural adequacy, and integrity of the member or on the structure.

d) A detailed repair plan including material, method, and equipment to be used.

e) Verification that the repair plan complies with the applicable standards for the type of work.

f) All relevant supporting information, including material test results, field measurements and observations, production records, photographs, and structural analysis calculations used for determining that the performance and function originally expected from the member shall be met.

g) Causes of the defect and corrective action to be taken to prevent recurrence of the defect in future production, delivery, or installation.

909.10 BASIS OF PAYMENT

909.10.01 Prestressed Concrete Members (Type) Fabrication - Item
Prestressed Concrete Members Containing Silica Fume (Type) Fabrication - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

909.10.02 Payment Adjustment for Rapid Chloride Permeability

For concrete members containing silica fume, lots of members with an average value of rapid chloride permeability exceeding 1,500 Coulombs and less than or equal to 2,000 Coulombs shall be accepted with a payment reduction in addition to the repair method required in Table 2. The payment reduction shall be calculated and applied as follows:

a) The price for the fabrication items in the Contract shall be converted to an equivalent price per metre length for each member type in the lot.

b) P_f, the percent payment reduction factor for each lot = 10%

c) For each member type in the lot, the payment reduction = (P_f) x (Equivalent price per metre length) x (Length of Members).

d) Total payment reduction for each lot is the sum of the individual payment reductions for each member type calculated in ‘c’.

909.10.03 **Prestressed Concrete Members (Type) Delivery - Item**
Prestressed Concrete Members Containing Silica Fume (Type) Delivery - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

909.10.04 **Prestressed Concrete Members (Type) Installation - Item**
Prestressed Concrete Members Containing Silica Fume (Type) Installation - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

TABLE 1
Tolerances

Item	Tolerances
Length: Straight-line measurement taken horizontally at the mid-height of member	± 1.0 mm/m; not to exceed ± 25 mm maximum
Overall Depth	± 8 mm for depths up to 600 mm ± 12 mm for depths over 600 mm
Flange Depth and Web Width for Members Without Voids	Flange depth ± 5 mm Web width -5/+10 mm
Flange Depth and Web Width for Members With Voids	Flange depth ± 10 mm Web width ± 10 mm
Width: Flanges and box members	± 10 mm
Sweep: I-members, spaced box members and spaced hollow slab members Abutting box and hollow slab girders	1 mm/m length of member. ± 10 mm
Squareness and Plumbness	1 in 200 maximum
Camber Difference: Between adjacent members spaced apart Between adjacent members placed side-by-side	 25 mm 15 mm
Hold-Down Position Along Length	± 300 mm
Void and Diaphragm Position Along Length	± 25 mm
Concrete Cover Over Reinforcing Steel	Unless otherwise specified in the Contract Documents, the tolerance for concrete cover over reinforcing steel shall be -5/+15 mm
Stirrup Projection	-10/+15 mm

TABLE 2
Defects and Deficiencies Repairable by Standard Methods

Repairable Defects and Deficiencies	Condition	Repair Method
Honeycombing, Voids, Cavities, Spalls, and Delaminations	Any area less than an equivalent area of 300 x 300 mm with no reinforcing steel or strand exposed.	a) Square all sides of the repair area. b) Sawcut perimeter of removal area to a depth of 10 mm or to the depth of reinforcing steel or strands, whichever is less. c) Remove all loose concrete using a chipping hammer or hand tools. d) Insert corrosion resistant wire mesh and anchors. e) Abrasive blast-clean all concrete surfaces to be patched according to OPSS 929. f) Remove all dust and loose material from the prepared surface by using compressed air. g) Moisten area to be repaired. h) Fill repair area with concrete or a proprietary patching material. i) Cure concrete according to moist curing requirements of this specification. Cure proprietary patching material according to the manufacturer's recommendations.
Low Cover	Any cover readings less than 25 mm and greater than or equal to 20 mm	The entire surface of the member shall be sealed, except areas against which new concrete is to be placed or in contact with bearings.
Compressive Strength	Any lot with 28-Day compressive strength lower than specified, but not more than 4.0 MPa lower than specified.	The entire surface of the member shall be sealed, except areas against which new concrete is to be placed or in contact with bearings
Rapid Chloride Permeability	Any lot of concrete containing silica fume with rapid chloride permeability value exceeding 1,000 and less than or equal to 2,000 Coulombs and lots of all other concrete with rapid chloride permeability value exceeding 2,500 and less than or equal to 3,500 Coulombs.	The entire surface of the member shall be sealed, except areas against which new concrete is to be placed or in contact with bearings
Air Void System Parameters	Any lot with spacing factor greater than 0.200 mm, but less than or equal to 0.250mm.	The entire surface of the member shall be sealed, except areas against which new concrete is to be placed or in contact with bearings
Sweep	Sweep greater than 1.0 mm /m length but less than or equal to 1.5 mm/m length.	Push or pull the members to within tolerance. Members that can be brought into tolerance and maintained at that position without visible signs of distress shall be accepted. Members greater than or equal to 1,900 mm in depth shall be pulled or pushed at both the top and bottom flange.

CERTIFICATE OF CONFORMANCE

Contract Number: ……

Contractor: ……

Location / Structure: ……

Work, Component(s)/Element, or Product: ……

……

……

I, _____ (print name), P. Eng. _____ (Professional Engineers of Ontario License Number) certify that the above-noted part of work, component, or product have been constructed in conformance to the requirements of the Contract Documents.

Seal and Signature

Date_____

DISTRIBUTION: 1) Contractor
2) Contract Administrator or Project Manager File

OPSF 539-1 (March 2021)

MANUFACTURER'S CERTIFICATE OF CONFORMANCE

Contract Number: ……..……

Contractor: ……..……

Location / Structure: ……..……

Plant / Manufacturer: ……..……

Work, Component(s)/Element, or Product: ……
……
……

I, _____ (print name), P. Eng. _____ (Professional Engineers of Ontario License Number) certify that the above-noted part of work, component, or product have been constructed in general conformance to the requirements of the Contract Documents.

(Attach documents per Contract Documents (examples: test results, production records) outside of form)

Seal and Signature

_____
Date

DISTRIBUTION: 1) Contractor
2) Contract Administrator or Project Manager File

OPSF 906-1 (March 2021)

REQUEST TO PROCEED

Contract Number:		**Request to Proceed Number:**	
Contractor Name:		**Consultant Name:**	
Location / Structure Site:			
Description of the work:			
Work / Component(s) or Product:			
Applicable specification(s) /special provision(s):			

This is to confirm that the above stage of work, component or product has been completed according to the general requirements of the Contract Documents.

Submitted by: _____ Time & Date: _____
Contractor's Representative
(Printed Name and Signature)

Received by: _____ Time & Date: _____
Contract Administrator or Project Manager
(Printed Name and Signature)

DISTRIBUTION: 1) Contractor
2) Contract Administrator or Project Manager File

OPSF 906-2 (March 2021)

NOTICE TO PROCEED

Contract Number:		**Request to Proceed Number:**	
Contractor Name:		**Consultant Name:**	
Location / Structure Site:			
Description of the work:			
Work / Component(s) or Product:			
Applicable specification(s) /special provision(s):			

The Contractor may proceed to the next operation as of the date of this notice.

Any Notice to Proceed by the Owner or its Contract Administrator or Project manager of the Work and Materials of the Contractor does not relieve the Contractor from any responsibility or obligation for the proper performance of the Work in general conformity with the requirements of the Contract Documents. As well, the Notice to Proceed imposes no liability upon the Owner or its Contract Administrator or Project Manager and is not to be interpreted as an approval or acceptance of the Work or the Materials by the Owner that the Work and Materials was completed or supplied in general conformance with the Contract Documents.

Issued by: _____ Time & Date: _____
Contract Administrator or Project Manager
(Printed Name and signature)

Received by: _____ Time & Date: _____
Contractor's Representative
(Printed Name and signature)

DISTRIBUTION: 1) Contractor
2) Contract Administrator or Project Manager File

OPSF 906-3 (March 2021)

CONCRETE CONSTRUCTION REPORT

CONTRACT NO.	REGION	HIGHWAY NO.	DATE OF PLACEMENT YEAR	MONTH	DAY	SPECIMENS MADE AT AM PM
						TEST AT DAYS HOURS

STRUCTURE NAME	SITE NO.	TYPE OF TEST 1 - COMPRESSIVE CYLINDERS 2 - FLEXURAL BEAMS 3 - AUTOGENOUS CYLINDERS 4 - TENSILE CYLINDERS 5 - COMPRESSIVE CUBES 6 - AIR VOID SYSTEM 7 - RAPID CHLORIDE PERMEABILITY 8 - LINEAR SHRINKAGE

LOT NO.	SUBLOT NO.	END RESULT SPEC YES ☐ NO ☐

TEST LOCATION AND STATION NUMBER	TYPE OF WORK (e.g. bridge, sidewalk)	LOCATION IF TYPE OF WORK IS A BRIDGE (e.g. abutment)

NAME OF CONTRACTOR PLACING CONCRETE	NAME AND LOCATION OF READY MIX CONCRETE SUPPLIER

CONCRETE MIX DESIGN

CONCRETE MIX DESIGN NUMBER	YEAR	SPECIFIED 28 DAY STRENGTH (MPa)	TICKET OR TRUCK NUMBER

FIELD ADJUSTMENTS

SUPERPLASTICIZER	AIR ENTRAINING ADMIXTURE
RETARDING ADMIXTURE	WATER

CONCRETE SAMPLING , INITIAL CURING, TESTER AND TESTING COMPANY IDENTIFICATION

AIR TEMPERATURE (°C)	FIELD SAMPLE NUMBER (s)	NUMBER OF SPECIMENS IN THE SET

COMPOSITE SAMPLE TEST RESULTS			CYLINDER/SPECIMEN CURING TEMPERATURE DURING THE FIELD CURING PERIOD	
SLUMP (mm)	AIR CONTENT (%)	CONC. TEMPERATURE (°C)	MINIMUM (°C)	MAXIMUM (°C)

FIELD TESTING COMPANY'S NAME	TESTER'S LAST NAME, INITIAL
TESTER'S CERTIFICATION ACI ☐ CCIL ☐	TESTER'S SIGNATURE, DATE
MTO INSPECTOR'S LAST NAME, INITIALS	MTO INSPECTOR'S SIGNATURE, DATE

LABORATORY USE ONLY

NAME AND LOCATION OF LABORATORY	DATE RECEIVED (Y/M/D)	AGE AT TEST	DATE TESTED (Y/M/D)	TYPE OF MOULD (Plastic, Cardboard, other)

CYLINDER A			CYLINDER B			CYLINDER C		
LAB. CYLINDER NO.		CYLINDER CONDITION	LAB. CYLINDER NO.		CYLINDER CONDITION	LAB. CYLINDER NO		CYLINDER CONDITION
WEIGHT	FORM OF BREAK	STRENGTH (MPa)	WEIGHT	FORM OF BREAK	STRENGTH (MPa)	WEIGHT	FORM OF BREAK	STRENGTH (MPa)

OPSF 909-1 (June 2021)

Appendix 909-A, November 2021
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

Several revisions have been made to the technical information of OPSS 909. It is recommended that the designer and the users read the specification in its entirety to become familiar with the differences and necessary requirements for municipal use.

The designer should specify the following in the Contract Documents:

- Concrete compressive strength. (909.05.03)

- Concrete strength at transfer. (909.07.12, 909.07.14.03)

Clause 909.07.20 requires the use of a Certificate of Conformance as shown on form OPSF 539-1. If a form other than OPSF 539-1 is to be used for submission purposes, the alternate form should be invoked by reference in the Contract Documents and the specification should be amended to remove reference to OPSF 539-1.

Clause 909.04.02.05 requires the use of a Manufacturer's Certificate of Conformance as shown on form OPSF 906-1. If a form other than OPSF 906-1 is to be used for submission purposes, the alternate form should be invoked by reference in the Contract Documents and the specification should be amended to remove reference to OPSF 906-1.

Clause 909.04.02.05 requires the use of a Request to Proceed as shown on form OPSF 906-2. If a form other than OPSF 906-2 is to be used for submission purposes, the alternate form should be invoked by reference in the Contract Documents and the specification should be amended to remove reference to OPSF 906-2.

Clause 909.04.02.05 requires the use of a Notice to Proceed as shown on form OPSF 906-3. If a form other than OPSF 906-3 is to be used for submission purposes, the alternate form should be invoked by reference in the Contract Documents and the specification should be amended to remove reference to OPSF 906-3.

Clause 909.07.15.02 requires the use OPSF 909-1 for reporting concrete test information. If a form other than OPSF 909-1 is to be used for submission purposes, the alternate form should be invoked by reference in the Contract Documents and a special provision should be written to remove reference to OPSF 909-1.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

CONSTRUCTION SPECIFICATION FOR STRESSING SYSTEMS FOR POST-TENSIONING

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910-A Commentary

910.01 SCOPE

This specification covers the requirements for post-tensioning and grouting of prestressed concrete.

910.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

910.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

910.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 905 Steel Reinforcement for Concrete

Ontario Provincial Standard Specifications, Material

OPSS 1302 Water
OPSS 1304 Packaged Silica Fume Dry Grout Mixture for Post Tensioning
OPSS 1440 Steel Reinforcement for Concrete

Ontario Ministry of Transportation Publications

Structural Manual:
Division 1 - Exceptions to the Canadian Highway Bridge Design Code

Canadian Standards Association

A23.2-1B Viscosity, Bleeding, Expansion, and Compressive Strength of Flowable Grout [Part of CSA A23.1-04/A23.2-04, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete]
A283-00 (2003) Qualification Code for Concrete Testing Laboratories
S6-00 Canadian Highway Bridge Design Code

ASTM International

A 53/A 53M-04a	Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
A 416/A 416M-02	Steel Strand, Uncoated Seven-Wire for Prestressed Concrete
D 2239-03	Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter
D 3350-04	Polyethylene Plastics Pipe and Fittings Materials
D 4285-83 (1999)	Indicating Oil or Water in Compressed Air

International Organization for Standardization/International Electrotechnical Commission

ISO/IEC DIS Guide 17025

910.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Calibration means the process of determining experimentally the absolute values corresponding to the gradation on a scale.

Cementing Materials means as defined in OPSS 1304.

Coupler means a device for the joining of two post-tensioning tendons or prestressing bars by means of a mechanical connector.

Deviator means a length of steel pipe placed in deviation blocks or deviation diaphragms to provide a means of changing direction of external tendons.

Engineer means a professional engineer licensed by the Professional Engineers Ontario to practice in the Province of Ontario.

Grout means an initially fluid mixture of cementing materials, aluminum powder, water, and approved admixtures.

Post-Tensioning means a method of prestressing in which tendons are tensioned after the concrete has reached a predetermined strength.

Primary Tendon Anchorages means the anchorage on longitudinal tendons.

Proposal means a Contractor's submission of changes, when engineering design is required, affecting the original design.

Splice-Prestressing Tendon means a connection of one prestressing tendon to another by means of a mechanical connector.

Sublot means the six cubes prepared at one grout material sampling used to determine the 28-Day compressive strength.

Tendon means a high strength steel element consisting of one or more wires, strands, or bars and used to impart prestress to the concrete.

Tensile Strength means the breaking load of the tendon per unit area established by tensile testing.

Vent means an inlet to permit injecting grout into the duct or an outlet to provide for the escape of air and grout, and to bleed or drain water.

Yield Strength means the stress at which the tendon exhibits a specified deviation of proportionality of stress and strain.

910.04 SUBMISSION AND DESIGN REQUIREMENTS

910.04.01 Submission Requirements

910.04.01.01 General

All Working Drawings, stressing details, and calculations shall bear the seal and signature of an Engineer.

When other authorities are involved in the approval of the design or construction of a highway structure, the submission shall be made at least 5 weeks prior to commencement of work and one additional copy of the required submission shall be provided for each authority.

Work shall not commence until written notice to proceed has been given by the Contract Administrator.

At least five weeks prior to commencement of the work, five copies of any proposal shall be submitted to the Contract Administrator.

910.04.01.02 Post-Tensioning Working Drawings

At least three weeks before commencement of the placing of post-tensioning materials, five sets of all Working Drawings shall be submitted to the Contract Administrator. These drawings shall include the following information:

a) Design details

b) Slip

c) Calculation data

d) Sequence of stressing

e) Details of the

   i. Ducts
   ii. Supports
   iii. Vents
   iv. Anchorages

Details of anchorages for post-tensioning tendons shall be according to the supplier's requirements.

All proposed post-tensioning systems shall meet the induced slip requirements specified in the Contract Documents.

Where post-tensioning tendons are anchored internally in concrete, anchorage shall be by means of bulbs crimped onto the ends of individual strands. When anchorages of this type are used, the Working Drawings shall also include the following information:

f) Anchorage bulb dimensions

g) Spacing of bulbs

h) Length of strand embedded in concrete

i) Ultimate load capacity of the anchorage

910.04.01.03 Stressing Details

At least two weeks prior to the commencement of stressing operations, three copies of the following information shall be submitted to the Contract Administrator:

a) The elongation calculations that take into account losses due to friction, elastic shortening, relaxation, shrinkage, and creep of concrete where these are applicable and all other causes.

b) The type of jack.

c) Friction of jack.

d) Jacking pressure.

e) Method of attaining the required slip.

f) Two copies of the prestressing steel manufacturer's stress-strain curves test reports.

910.04.01.04 Couplers

At least three weeks prior to commencement of the work, a copy of the manufacturer's catalogue giving complete data on the coupler material, installation procedures, and test reports from the manufacturer certifying strength and fatigue requirements shall be submitted to the Contract Administrator.

910.04.01.05 Prestressing Steel Test Certificates

Mill test certificates and stress strain curve test reports shall be according to OPSS 1440.

One copy of mill test certificates for all material to be used in the fabrication of the prestressing steel shall be available for review at the fabricating plant during fabrication. The mill test certificates shall show that the material is according to the Contract Documents.

Where mill test certificates originate from a mill outside Canada or the United States of America, the Contractor shall have the information on the mill test certificate verified by testing by a Canadian laboratory. This laboratory shall be certified by an organization accredited by the Standards Council of Canada to comply with the requirements of ISO/IEC 17025 for the specific tests or type of tests required by the material standard specified on the mill test certificate. The mill test certificates shall be stamped with the name of the Canadian laboratory and appropriate wording stating that the material is in conformance with the specified Contract requirements. The stamp shall include the appropriate material specification number, testing date, and signature of an authorized officer of the Canadian laboratory.

Two copies of the mill test certificates shall be submitted to the Contract Administrator when the material is shipped from the fabrication plant.

910.04.01.06 Certificate of Compliance

The Certificate of Compliance as prepared according to OPSS 1304 that is supplied with the packaged dry grout mixture shall be submitted to the Contract Administrator prior to commencement of grouting.

910.04.01.07 Return of Submissions

Two copies of each submission to be returned shall be marked as one of the following:

a) Stamped with the wording that allows for permission to construct.

In this case, work can commence on receipt of the drawing by the Contractor. A copy of these drawings shall be available at the site prior to and during construction.

b) Stamped with the wording that allows for permission to construct as noted.

In this case, work can start on receipt of the drawings by the Contractor. The drawings shall be updated as noted and shall have a stamp affixed that is signed by an Engineer stating the drawings have been revised according to the noted comments. A copy of the stamped updated drawings shall be available at the site prior to and during construction.

c) Showing only required changes.

In this case, the drawings shall be updated as required and the submission process repeated.

910.04.02 Design Requirements

Design shall be according to CSA S6 and the Structural Manual, Division 1.

910.05 MATERIALS

910.05.01 Ducts

910.05.01.01 General

Sheaths for internal post-tensioning ducts shall be formed from bright steel, galvanized steel, or plastic. The sheaths, including joints, shall be watertight under an internal pressure of 350 kPa shall have corrugations and be non-reactive with concrete, tendons, or grout.

Sheaths for external post-tensioning shall be made from smooth, rigid polyethylene.

All sheaths shall be provided with suitable devices for the injection and discharge of grout after prestressing. Air vents shall be provided at all high points on the tendon sheaths that are continuous over more than one span. Air and drainage vents shall be provided at other locations as specified in the Contract Documents.

Sheaths shall be capable of withstanding concrete pressures without excessive deformation or permitting the entrance of cement paste during the placing of concrete. The ducts shall have sufficient rigidity to maintain the required profile between points of supports.

For single strand or bar tendons, the inside diameter of the sheaths for post-tensioning ducts shall be at least 6 mm larger than the nominal diameter of the strand or bar. For multiple strand tendons, the inside cross-sectional area of the sheath shall be at least twice the cross-sectional area of the prestressing tendon.

The diameter of a duct or an equivalent diameter of a non-circular duct shall not exceed 40% of the least gross concrete section thickness at the duct.

910.05.01.02 Steel Sheaths

Rigid steel sheaths shall have a wall thickness of at least 0.60 mm and shall be capable of being formed to an inside radius of 9 m without distress. Semi-rigid steel sheaths shall have a wall thickness of at least 0.25 mm and shall be capable of being formed to an inside radius of 3.50 m without distress.

910.05.01.03 Plastic Sheaths

Plastic sheaths, including their splices, shall be made of high-density polyethylene according to ASTM D 3350, Cell Classification 324420C, and shall be vapour-tight and remain so after tendon installation and stressing.

Plastic for the external post tensioning sheaths shall be treated to resist deterioration from ultraviolet light according to ASTM D 3350 and coded D or E.

The plastic sheath shall be manufactured according to ASTM D 2239.

Plastic sheaths shall not be used when the radius of curvature of the tendon is less than 10 m. The sheaths shall be capable of bending to the specified minimum radius of curvature without damage. The sheath wall thickness shall be such that for the specified minimum radius of curvature, the remaining wall thickness after a tendon movement of 750 mm under a tendon stress of 80% of the specified strength shall not be less than 1 mm. For curved sheaths, the radial force as exerted by a single strand on the sheath wall shall not exceed 40 kN/m.

The plastic sheaths shall be according to the following:

a) For sheaths with an inside diameter of 50 mm or less, a 3 m length supported at the ends shall not deflect under its own weight by more than 75 mm at a temperature of not less than 20°C.

b) For sheaths with an inside diameter of more than 50 mm, a 6 m length supported at the ends shall not deflect under its own weight by more than 75 mm at a temperature of not less than 20°C.

c) The sheath shall not deform more than 3 mm under a point load of 445 N applied through a No. 10 reinforcing bar located between the corrugation ribs at a temperature of not less than 20°C.

   Sheaths and their splices for external post-tensioning shall be smooth, seamless, and capable of withstanding a grouting pressure of at least 1,000 kPa.

d) Material thickness shall be as follows:

   i. Corrugated, internal duct 1.25 mm $\pm$ 0.25 mm.
   ii. External duct shall have an external diameter to wall thickness ratio of 21 or less.

910.05.01.04 Sheaths at Deviators

The sheaths within a deviator for post-tensioning tendons shall be galvanized steel pipe according to ASTM A 53/A 53M, Type E, Grade B, with a wall thickness of not less than 3 mm. The sheath shall be formed to conform to the tendon alignment.

910.05.01.05 Duct Vents

Vents shall be a 20 mm minimum diameter flexible tubing material capable of withstanding the grouting pressures applied to them.

910.05.02 Prestressing Steel

Prestressing steel shall be low alloy steel bar or uncoated, low relaxation 7-wire strand according to OPSS 1440.

910.05.03 Anchorages and Couplers

910.05.03.01 General

When tested in an unbonded condition, anchorages and couplers for post-tensioning shall develop at least 95% of the ultimate strength of the tendons, without exceeding the anticipated set. After tensioning and seating, anchorages shall be capable of sustaining the applied loads without slippage, distortion, or other changes that could result in loss of prestress.

910.05.03.02 Anchorages

The dimensions and details of anchorages, including any reinforcement required to resist tensile, bursting, and anchorage bearing stresses within the local zone, shall be based on the strength of the tendon and the strength of the concrete at transfer as specified in the Contract Documents.

Primary tendon anchorages shall be provided with steel end caps which cover the strand ends and wedges. The steel cap shall have 3 mm minimum wall thickness, and shall have attachments and gaskets that will allow the cap to withstand full grouting pressures. End caps should be vented to ensure complete filling with grout.

Anchorages for unbonded tendons shall not cause a reduction in the total elongation under ultimate load of the tendon to less than 2% measured in a minimum gauge length of 3 metres.

910.05.03.03 Couplers

Couplers shall be according to the submitted manufacturer's data that is approved by the Contract Administrator.

When specified in the Contract Documents, all coupling components for low alloy steel bar shall be protected by a coating material.

910.05.03.04 Testing

A dynamic test for unbonded tendons, shall be performed on a representative anchorage and coupler specimen and the results submitted to the Contract Administrator. The tendon shall withstand, without failure, 500,000 cycles from 60 to 66% of its minimum specified ultimate strength and also 50 cycles from 40 to 80% of its minimum specified ultimate strength. The period of each cycle involves the change from the lower stress level to the upper stress level and back to the lower. The specimen used for the second dynamic test need not be the same used for the first dynamic test. Systems using multiple strands, wires, or bars may be tested using a test tendon of smaller capacity than the full-sized tendon. The test tendon shall duplicate the behavior of the full-sized tendon and generally shall not have less than 10% of the capacity of the full-sized tendon. Dynamic tests are not required on bonded tendons, unless the anchorage is located or used in such manner that repeated load applications can be expected on the anchorage.

910.05.04 Associated Hardware

Only hardware, including spacers and support devices for the sheaths, that is capable of withstanding the loads placed on it, and that is approved by the Owner shall be used. All embedded hardware within 50 mm of exposed faces shall be coated with an acceptable material or be of an acceptable non-metallic material.

910.05.05 Steel Reinforcement

Steel reinforcement shall be according to OPSS 1440.

910.05.06 Dry Grout Mixture

The silica fume dry grout mixture shall be a packaged, commercially available grout, according to OPSS 1304. The packaged dry grout mixture shall be stored in a dry condition up to the time of its use and shall be used within one month of packaging.

910.05.07 Water

Water shall be according to OPSS 1302.

910.05.08 Grout

The grout shall have the following physical properties:

a) A-28-Day compressive strength of not less than 60 MPa.

b) Shall not bleed or segregate when allowed to stand for 1 hour.

c) An expansion of 6% $\pm$ 2% of its original volume when measured at 1 hour.

d) The time measurement for the viscosity of the grout shall be between 11 and 25 seconds when the measurements are performed immediately after the grout is removed from the mixer and when measured 30 minutes after mixing.

   The grout used for the first set of viscosity measurements shall be discarded after testing and shall not be used for the 30-minute measurement. The grout used for the 30-minute measurement shall be left undisturbed in a clean container covered with a lid until the measurement is performed.

910.06 EQUIPMENT

910.06.01 Air Compressor

The air compressor for air blasting shall have a minimum capacity of 3.5 m^3/min. The compressed air shall be free of water and oil according to ASTM D 4285.

910.06.02 Stressing Equipment

Pressure gauges, dynamometers, tension meters, load cells, or other suitable devices shall be used for controlling and measuring the tendon forces and shall be according to the following:

a) Capable of measuring the forces to an accuracy of $\pm$ 2%.

b) Each gauge shall be capable of indicating forces directly in Newtons or be accompanied by a chart by which the reading can be converted into such units of force.

c) The indicating dials of gauges shall be at least 150 mm in diameter.

d) Friction losses in jacks, hoses, and connections shall be determined and recorded.

e) Each gauge shall be accompanied by a certified calibration curve that bears the seal and signature of an Engineer.

f) The gauges shall have been calibrated within the six-month period immediately preceding the commencement of the work.

g) The forces to be measured shall be within 25 and 75% of the maximum graduated capacity of the gauge unless calibration data clearly establishes the gauge is accurate over a wider range.

h) Pressure gauges shall not fluctuate excessively and shall remain steady until the jacking load is released.

i) Gauges shall be mounted near eye level and within 2 m of the operator and positioned so that readings can be obtained without parallax.

j) Provision shall be made for accommodating two gauges at each jack and pump combination.

910.06.03 Grouting Equipment

The grouting equipment shall consist of a mixer, separate holding tank, and pump.

The mixer shall be of the mechanical type with a speed of 1200 to 2000 rpm. The mixer shall be equipped with a calibrated measuring device for determining the quantity of mixing water. The device shall measure the total quantity of water used in each batch of the grout to an accuracy of $\pm$ 2%. The device shall be accompanied by a certified calibration curve that bears the seal and signature of an Engineer. The device shall have been calibrated within the six-month period immediately preceding the commencement of work. The mixer shall be equipped with a visible timing device suitable for controlling the mixing time.

The holding tank shall be capable of keeping the mixed grout continuously in motion until it is used. The outlet to the pump shall have a 5 mm screen.

The grout pump shall be capable of grouting to a pressure of at least 1 MPa and shall be equipped with a pressure gauge and a pressure relief valve set to release at a pressure of 1 MPa. The pressure gauge shall be accompanied by a certified calibration curve which bears the seal and signature of an Engineer, shall have an accuracy of $\pm$ 5% and shall be calibrated at least once a year.

The grouting equipment shall be of sufficient capacity to ensure that the grouting of the longest duct can be completed within 30 minutes after mixing. The velocity of grout in the duct shall be between 6 and 12 m/min. and the pressure shall be compatible with the length and size of the duct.

The grout hoses and their rated pressure capacity shall be compatible with the pump output and the maximum grouting pressure. All connections from the grout pump to the duct shall be airtight so that air cannot be drawn into the duct.

The configuration of the equipment shall be such that the grout can be recirculated to the holding tank if stoppage occurs in the grouting.

Standby equipment such as a water flushing system and compressed air shall be available at the site before the commencement of grouting in case of a breakdown of the equipment during grouting operations. Suitable equipment to grout a number of ducts simultaneously shall be readily available.

910.06.04 Grout Testing Equipment

The following grout testing equipment shall be provided:

a) Equipment according to CSA A23.2-1B for the viscosity, bleeding, and expansion measurements.

b) Stainless steel moulds for preparing cubes for compressive strength tests.

c) Thermometers for measuring air and grout temperature.

910.06.05 Malfunction of Gauges

Gauges shall be replaced immediately when a malfunction is noted.

910.07 CONSTRUCTION

910.07.01 General

910.07.01.01 Prestressing Staff

The work shall be done by staff employed by or licensed by the manufacturer of the stressing system used.

The staff employed to supervise the work of tensioning and grouting shall have a working knowledge of the prestressing system used and shall be capable of evaluating the forces, gauge pressures, elongations, and method by which the prestressing system transfers the forces to the structure. They shall have a minimum of 5 years experience in carrying out this type of work within the last 10 years. The staff shall be present during these operations and during the concreting operations to ensure the post-tensioning components of the work are not adversely affected.

910.07.01.02 Welding

Except as permitted in the following paragraph, welding equipment shall not use the prestressing steel or sheath as an electrical ground. Welding shall not be permitted within 3 m of the prestressing steel.

Welding of the prestressing tendons will only be permitted to facilitate pulling the tendon through the sheath as specified below. Where the ends of strands are welded together to facilitate pulling the tendon through the sheath, the length of the tendon used as an electrical ground or 1 m, whichever is greater, shall be cut off from the welded end prior to stressing. Care shall be exercised at all times to prevent the possibility of heat destroying the tensile properties of the steel.

910.07.01.03 Surface Condition

All material shall be clean and free of oil, dirt, scale, and pitting. A light rust coating on the steel is acceptable.

910.07.02 Prestressing Steel, Sheaths, and Anchorages

910.07.02.01 Installation

Prestressing steel, sheaths, anchorages, couplers, and local reinforcing steel at anchorages shall be placed in the positions shown in the Contract Documents and held in the correct location during the operations of placing and consolidating concrete.

The sheaths shall be secured at intervals not exceeding 1 m and a smooth profile shall be maintained. All joints in sheaths and between the sheath and other hardware shall be protected against the ingress of laitance during concreting and against the entry of any deleterious material before, during, and after concreting.

Sheaths and anchorages shall be placed according to the following tolerances that apply to horizontal and vertical placement:

a) Longitudinal sheath $\pm$ 15 mm.

b) Transverse sheath $\pm$ 10 mm.

c) Anchorage $\pm$ 10 mm.

Couplers in strand or high strength bars are not permitted in the work unless specified in the Contract Documents.

When couplers are specified in the Contract Documents, they shall be installed according to the recommendations of the manufacturer of the prestressing system used.

910.07.02.02 Vents

Vents shall be installed as follows:

a) At the anchorages of the tendon.

b) At the high points of the duct.

c) At the lowest point of a tendon having a small radius such as a vertical loop.

d) At major changes in the cross-section of the duct such as trumpets of couplers and anchorages.

Vents shall extend at least 500 mm above the highest point on the profile of the duct in which the vent is placed.

Holes in the duct shall be the same as the inside diameter of the vent.

910.07.02.03 Reinforcing Steel

The placing of reinforcing steel as sheath support bars, spirals, tensioning rings, and reinforcing grids at anchorages shall be according to OPSS 905.

910.07.03 Prestressing Steel Post Tensioning

910.07.03.01 General

The Contract Administrator shall be notified when the prestressing steel is available for sampling at least one week in advance of stressing.

Prestressing steel samples selected by the Contract Administrator for testing shall be labelled by the Contractor and contain the following information:

a) Manufacturers identification number.

b) Reel number.

c) Heat number.

d) Location of sampled area.

910.07.03.02 Provision of Material Samples

Samples of prestressing materials and dry grout mixture shall be submitted to the Contract Administrator as follows:

a) For strand, 1 sample 1.0 m long from each reel.

b) For bar, 1 sample 1.0 m long.

c) For anchorages and couplers, samples will be selected by the Contract Administrator on a random basis.

d) For dry grout mixture, representative samples of the packaged material shall be submitted to the Contract Administrator when requested.

910.07.03.03 Tensioning

Tensioning shall not commence until the concrete has attained the strength specified in the Contract Documents.

Tensioning shall be carried out as specified in the Contract Documents and as shown on the stamped Working Drawings.

After tensioning, all openings and vents along the ducts shall be temporarily plugged or sealed until the grouting is performed.

910.07.03.04 Measurement of Tensioning and Variation in the Prestress Force

The force in the tendons shall be determined by means of the pressure gauge and shall be continually verified by means of measuring the tendon elongation. The pressure gauge readings and the elongations for the first five tendons of each type stressed shall be recorded at intervals of 25% of the maximum prestress force including the final reading.

The measured elongations of individual tendons at the specified jacking force, based on the gauge pressures, shall be within -3 to +9% of the calculated values.

When the actual elongation is outside the tolerance of -3 to +9%, jacking shall be stopped at that tendon and the Contractor shall prepare and submit a report rationalizing the observed difference.
The variation from specified total prestress force over the complete component cross-section, including broken strands, shall not exceed $\pm$ 5%. The distribution of the variation of this total prestress force across the component cross-section shall be subject to approval by the Contract Administrator.

910.07.03.05 Maximum Tension

In no case shall the low relaxation steel be tensioned above 85% of its tensile strength and in no case shall any steel be tensioned above 94% of its yield strength.

910.07.03.06 Stressing Records

Records of elongation, calibrated jacking pressure readings, and slippage shall be kept at all times and submitted to the Contract Administrator.

910.07.03.07 Cutting of Tendons

Tendons shall not be cut until the stressing records have been reviewed by the Contract Administrator and written permission to grout has been given by the Contract Administrator. Care shall be exercised at all times in the cutting of tendons to avoid the possibility of adversely affecting the prestressing steel.

Unless other methods are approved by the Contract Administrator cutting of the tendons shall be by mechanical means.

910.07.04 Grouting

910.07.04.01 General

The tendons shall not be grouted until concrete has been placed in the anchorage recesses and permission to grout has been given by the Contract Administrator. Where it is not possible to place concrete in the anchorage recesses prior to grouting, the anchorages shall be sealed to resist the pressure during grouting. Once permission to grout has been received in writing from the Contract Administrator, grouting shall be carried out as soon as possible, but in no case shall any prestressing steel be left ungrouted for more than 7 Days after receipt of permission to grout or more than 14 Days after completion of tensioning.

910.07.04.02 Preparation for Grouting

Dry, oil-free compressed air shall be blown through each duct. Each vent shall be tested in turn to ensure the ducts, vents, inlets, and outlets are capable of accepting the injection of grout.

All ducts shall be cleaned and made free of all deleterious material that may impair bonding of the grout to the ducts and tendons by flushing with water and blowing out with dry, oil free compressed air. Steam shall not be used for cleaning.

All grout vents of each duct shall be open when grouting starts. The elevation of the end of the ejection vent at the free end shall be higher than the high point vents along the duct.

910.07.04.03 Grout Mixing

A standard batch size shall be established and the size of the batch to be used shall be reported to the Contract Administrator prior to the commencement of grouting. The standard batch size shall be used throughout the grouting operation.

The mixing procedure for the grout shall be as follows:

a) The required amount of water shall be added to the mixer by means of the calibrated measuring device attached.

b) Packaged dry grout mixture shall be added to the mixer.

c) The grout shall be mixed for a minimum of 1 minute after the dry grout mixture is added and until the grout is mixed thoroughly and uniformly.

The time between the addition of the dry grout mixture and pumping of the grout shall not exceed 15 minutes. Water shall not be added to the grout after initial mixing.

The holding tank shall be kept at least partially full at all times during the pumping operation to prevent air from being drawn into the duct.

910.07.04.04 Temperature of Grout

The temperature of the grout in the holding tank at the time of injection shall not be less than 15°C or more than 30°C and shall be measured hourly.

910.07.04.05 Grouting Procedures

The temperature of the concrete and the duct shall be at least 5°C before grouting commences and shall be maintained above this minimum temperature at all times during the grouting operation and for 72 hours after grouting is complete.

Grouting shall commence as soon as possible after mixing and shall be carried out in one operation without interruption. A continuous, one-way flow of grout shall be maintained. The pumping pressure at the injection vent shall not exceed 1 MPa. The grout shall be pumped from the lowest grout inlet.

The consistency of grout flowing from a vent shall be examined to determine whether or not the grout is the same consistency as that being pumped in at the injection vent. When the grout is of the same consistency, an additional five litres of grout shall be permitted to flow out prior to closing that vent.

As grout of original consistency flows from the vents, the vents shall be successively closed as the filling of the duct progresses. When grout of original consistency flows from the ejection vent at the free end, that vent shall be closed. Pumping shall be resumed and the high point vents along the duct shall be re-opened, one at a time, starting with the vent closest to the injection vent. Vents shall not be resealed until grout of original consistency emerges. The injection tubes shall be sealed off under pressure when the duct is completely filled with grout. A pressure of approximately 500 kPa shall be maintained for at least 1 minute after sealing.

The grout tubes shall be topped up with grout if a subsidence of grout occurs when disconnecting the pump or pressure apparatus so that grout completely fills the ducts and openings. After the grout has hardened, the grout tubes shall be cut off flush with the surface of the deck and any tubes not completely full of grout shall be topped up flush with the surface of the concrete.

After grouting is completed, any residue of grout remaining on concrete surfaces adjacent to the vents shall be removed.

After grouting, loads shall not be applied to or removed from the structure until the grout has reached a compressive strength of at least 20 MPa. For the purposes of this clause, removal of falsework and formwork shall not constitute a load on the structure.

910.07.05 Quality Control

910.07.05.01 General

The 28-Day compressive strength test results of the grout from the manufacturer shall be submitted to the Contract Administrator upon receipt.

In addition to the quality control procedures initiated by the Contractor, the following work shall also be done.

910.07.05.02 Grout Mixture

910.07.05.02.01 General

Viscosity, bleeding, and expansion measurements and preparation of cubes for compressive strength tests shall be done on a level, vibration free surface.

The Contractor shall use staff from a testing laboratory certified by an organization accredited by the Standards Council of Canada according to CSA A283 for Additional Tests according to CSA A23.2-1B. The test cubes shall be prepared by this staff.

Grout mixture showing evidence of dampness, lumps, hardened pieces, or contamination shall not be incorporated in the work.

910.07.05.02.02 Bleeding, Expansion, and Viscosity Tests

Prior to the grouting operation and in the presence of the Contract Administrator, a trial batch shall be mixed and the grout tested according to CSA A23.2-1B for bleeding, expansion, and viscosity to ensure that the grout meets the requirements specified herein before the grouting is to proceed. The trial batch of grout shall not be used in the actual grouting operation.

During the grouting operation, the bleeding, expansion, and viscosity tests shall be performed according to CSA A23.2-1B on the grout sampled at the mixer. The tests shall be performed at least once a day and as requested by the Contract Administrator.

Copies of the bleeding, expansion, and viscosity test shall be submitted to the Contract Administrator. Any test result which indicates the grout is not meeting the requirements specified herein shall be reported immediately to the Contract Administrator and the grouting operation halted until the cause of the problem is identified and corrected. The grout supplier shall also be immediately notified when the grout mixed as specified fails to meet the test requirements for bleeding, expansion, and viscosity.

910.07.05.02.03 Sampling for Compressive Strength Tests

Cubes for compressive strength tests shall be prepared according to CSA A23.2-1B on site from the grout pumped into the ducts, as follows:

a) The total volume of grout used for grouting one structure represents one lot.

b) At least four random sublots of grout samplings shall be taken at the mixer for each lot. Six cubes shall be made from each sublot sampling to be used for the 28-Day compressive strength tests.

c) Three cubes shall be made from each sampling taken at the anchorage outlet. This sampling is for the Owners use only.

The sampling shall be taken once per day and as directed by the Contract Administrator.

The cubes shall be identified as coming from the mixer or the anchorage outlet and shall be stored at a temperature between 15 and 25°C and shall not be moved prior to demoulding. The cubes shall be demoulded within 24 hours $\pm$ 4 hours and the cubes representing the Owner's sample shall be given to the Contract Administrator. The cubes shall be presented in a sealed white opaque plastic bag containing at least 250 ml of water.

910.07.05.02.04 Early Compressive Strength Tests

The Contractor shall prepare and test the grout compressive strength test cubes according to OPSS 1304 to determine when the grout has attained a strength of 20 MPa.

The laboratory conducting the test shall be CSA certified as specified herein.

910.07.06 Prestressing Steel Friction Test

Where the elongations shown on the stamped stressing details of the Working Drawing submission and the actual elongations differ from the clause for Measurement of Tensioning, the Contract Administrator may require the Contractor to conduct a friction test on one or more tendons to check the theoretical value of friction used in the design and elongation calculation.

The results of these tests shall be submitted to the Contract Administrator.

910.07.07 Test Reports

A copy of all test reports shall be submitted to the Contract Administrator.

910.07.08 As Built Drawings

As built drawings shall be prepared by the Contractor as follows:

a) For all work incorporated into the completed structure that required the submission of Working Drawings.

b) For all changes from the original Contract Document requirements.

The as built drawings shall be submitted to the Contract Administrator in a reproducible format prior to final acceptance of work.

The as built drawings shall bear the seal and signature of an Engineer.

910.07.09 Management of Excess Material

Management of excess material shall be as specified in the Contract Document.

910.08 QUALITY ASSURANCE

910.08.01 Testing of Prestressing Steel

The testing of prestressing steel strand and bars shall be according to ASTM A 416/A 416M

910.08.02 Anchorages, Spirals, and Couplers

Anchorages, spirals, and couplers shall be examined for conformance with the Contract Documents and the manufacturers requirements.

910.08.03 Grout

Using the prepackaged samples submitted to the Contract Administrator, a trial batch may be made according to OPSS 1304 and tested for the specified properties.

The compressive strength test shall be according to CSA A23.2-1B.

Samples of the grout may be taken from the mixer and tested.

The grout shall be examined for acceptability as it flows from the vents and anchorages prior to closure.

910.08.04 Anchorage Outlet Sampling of Grout

The grout samples obtained from the anchorage outlet shall be tested and compared with the 28-Day compressive strength test cubes.

910.08.05 Material, Stressing Records, and Test Results

Post-tensioning material, stressing records, and test results shall be examined for conformance to the Contract Documents.

910.10 BASIS OF PAYMENT

910.10.01 Longitudinal Stressing System - Item
Transverse Stressing System - Item
Vertical Stressing System - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Fifty percent of the Contract price shall be paid on completion of the stressing. The remainder shall be paid after completion of the grout curing and review of the 28-Day compressive strength test results by the Contract Administrator and be based on any payment adjustment calculated.

910.10.02 Stressing System Payment Adjustment

The results of the compressive strength tests of the six cubes made for each sublot shall be averaged. The average of the test results for all sublots shall then be averaged. The Contract price for the stressing system will be reduced by 2% for each MPa this average is below 60 MPa.

The calculations will be based on the compressive strength of the cubes made from samples taken at the mixer.

Appendix 910-A, November 2005
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The following shall be specified in the Contract Documents:

- Proposed post-tensioning systems, induced slip requirements. (910.04.01.02)

- Other locations for air and drainage vents. (910.05.01.01)

- Strength of tendon and strength of concrete at transfer. (910.05.03.02)

- Coupling components for low alloy steel bar to be protected by a coating material. (910.05.03.03)

- Ultimate strength. (910.05.01.03.04)

- Location of prestressing steel, sheaths, anchorages, couplers, and local reinforcing steel at anchorages. (910.07.02.01)

- Couplers in strand or high strength bars when permitted in the work. (910.07.02.01)

- Concrete strength required for tensioning and tensioning procedures. (910.07.03.03)

- Anchorages, spirals, and couplers. (910.08.02)

- Post-tensioning materials, stressing records, and test results. (910.08.05)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

None

CONSTRUCTION SPECIFICATION FOR COATING STRUCTURAL STEEL SYSTEMS

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APPENDICES

911-A **Commentary**

911.01 SCOPE

This specification covers the requirements for the surface preparation and coating of structural steel and railing systems.

911.01.01 Specification Significance and Use

This specification has been developed for use in municipal oriented Contracts. The administration, testing, and payment policies, procedures, and practices reflected in this specification correspond to those used by many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

911.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

911.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 919 Formwork and Falsework

Ontario Provincial Standard Specifications, Material

OPSS 1704 Paint Coating Systems for Structural Steel

Ontario Ministry of Transportation Publications

Designated Sources for Materials (DSM)
Structural Manual

CSA Standards

S6:19 Canadian Highway Bridge Design Code

ASTM International

A123/A123M-15	Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
A143/A143M-07 (2020)	Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement
A153/A153M-16	Zinc Coating (Hot-Dip) on Iron and Steel Hardware
A780/A780M-20	Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings

B833-20	Zinc and Zinc Alloy Wire for Thermal Spraying (Metallizing) for the Corrosion Protection of Steel
C566-19	Test Method for Total Evaporable Moisture Content of Aggregate by Drying
D4285-83 (2018)	Test Method for Indicating Oil or Water in Compressed Air
D4417-21	Test Methods for Field Measurement of Surface Profile of Blast Cleaned Steel
D4541-17	Test Methods for Pull-Off Strength of Coatings Using Portable Adhesion Testers
D4940-15 (2020)	Test Methods for Conductimetric Analysis of Water Soluble Ionic Contamination of Blasting Abrasives
D6386-22	Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting
D7091-21	Non-Destructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to Ferrous Metals and Nonmagnetic, Nonconductive Coatings Applied to Non-Ferrous Metals

The Society for Protective Coatings (SSPC)

AB 1, March 2017	Mineral and Slag Abrasives
PA 1, June 2016	Shop, Field, and Maintenance Painting of Steel
PA 2, November 2018	Procedure for Determining Conformance to Dry Coating Thickness Requirements
PA 11, August 2008	Protecting Edges, Crevices, and Irregular Steel Surfaces by Stripe Coating
SP 1, August 2016	Solvent Cleaning
SP 8, November 2004	Pickling
SP 11, November 2013	Power Tool Cleaning to Bare Metal
VIS 1-2002	Visual Standard for Abrasive Blast Cleaned Steel
VIS 3-2004	Visual Standard for Power-and Hand-Tool Cleaned Steel

SSPC and National Association of Corrosion Engineers (NACE) Joint Publications

SP 5/NACE No. 1, January 2007	White Metal Blast Cleaning
SP 6/NACE No. 3, January 2007	Commercial Blast Cleaning
SP 10/NACE No. 2, January 2007	Near-White Blast Cleaning

SSPC, American Welding Society (AWS), and NACE Joint Publications

NACE no.12/AWS C2.23M/SSPC CS-23-2016	Application of Thermal Spray Coatings (Metalizing) of Aluminum, Zinc, and Their Alloys and Composites for the Corrosion Protection of Steel

Others

Federal Standard 595C Colors, 2017 - Published by U. S. General Services Administration

911.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Coating means a liquid, liquefiable, or mastic composition that is converted to a solid protective, decorative, or functional adherent film after application as a thin layer.

Coating System means a number of coats of metallic or paint coating, or both, separately applied in a predetermined order at suitable intervals to allow for setting, drying, or curing.

Dry Film Thickness means the thickness of a coating after it has dried throughout, after all the solvent has evaporated, and the coating has cured.

Escape means any visible emission or settlement of dust or debris, including abrasive media, paint chips, and coating material, outside the limits of the enclosure resulting from surface preparation or coating application.

Faying Surface means the mating surface of a member that is in contact with the mating surface of another member when joined together.

Final Surface Preparation means surface preparation as specified in the Contract Documents.

Interim Surface Preparation means an incomplete surface preparation that does not meet the requirements for the final surface preparation.

Metallic Coating means hot dip galvanizing or thermal sprayed metal coating.

Metallizing means application of thermal sprayed metal coating.

Paint Coating means a liquid or mastic composition that upon drying or curing is converted to a solid protective, decorative, or functional adherent film after application as a thin layer.

Paint Coating System means a number of coats of paint coating separately applied in a predetermined order at suitable intervals to allow for setting, drying, or curing.

Power Washed means the use of low pressure water to remove contaminants from the surface without damaging the coating. The water pressure shall be within the range of 7 to 10 MPa.

Railing System means steel tube rails, steel panels, steel posts, steel caps, steel panel anchorages, and steel splash guards, including all steel connections.

Recoat Time means the time recommended by the manufacturer for drying, curing, or setting of paint coating prior to application of subsequent coat.

Seal Coat means a paint coating used to seal thermal sprayed metal coating.

Slip Critical Connection means a connection where slippage cannot be tolerated, including those subject to fatigue or to frequent load reversal, or where the resultant deflections are unacceptable.

Spent Material means the spent abrasive, removed coating material, rust, or other debris or a mixture thereof generated during surface preparation.

Spot Measurement means the average of the three gauge readings taken per spot.

Structural Steel means the steel components of a structure, including lighting poles, traffic signal poles, bearing assemblies, deck drains, piles, and all other steel appurtenances and connections, excluding railing systems.

Surface Profile means the surface contour of a blast or power tool cleaned substrate, when viewed from the edges of the surface.

Sweep Blasting means a process of rapid movement of abrasive blast nozzle over a surface to remove deleterious substances and to roughen its surface profile.

911.04 DESIGN AND SUBMISSION REQUIREMENTS

911.04.01 Design Requirements

Design of enclosures and temporary supports shall be according to CSA S6, MTO Structural Manual, and OPSS 919.

911.04.02 Submission Requirements

911.04.02.01 General

Except for the material certification for the coating material, five sets of each of the following submissions shall be submitted to the Contract Administrator at least 3 weeks prior to commencement of coating operations, for information purposes only.

911.04.02.02 Written Notices

Written notice submissions shall include:

a) Details of the methods, procedures, and sequence of operations to be employed to complete the work, including Working Drawings and schedules.

b) Details of surface preparation and coating of areas that are difficult to access and the method of application.

c) Details of the proposed method for management of excess materials including collection, containment and disposal of all solid and liquid wastes.

911.04.02.03 Working Drawings

911.04.02.03.01 Environmental Protection

When the Contract contains a tender item for environmental protection, the Working Drawings shall include a detailed description of the environmental protection to be employed, including details of the enclosure, installation of the enclosure, and relocation procedure for the enclosure and equipment.

911.04.02.03.02 Restriction on Construction Loads

Working Drawings shall show the location and magnitude of all applied construction loads.

The Working Drawings shall state that the bridge, including all components required to support the enclosure system, can safely support all loads, including construction loads according to CSA S6 and the MTO Structural Manual and shall bear the seals and signatures of two Engineers who shall also verify the actual field condition of the structure prior to certifying the Working Drawings.

Where the applied construction loads exceed the limits specified in the Construction Load Limits clause, two Engineers shall be retained who shall act as an evaluation Engineer and a design-checking Engineer to carry out a structural evaluation. Such evaluation shall ensure that the bridge can safely support all loads according to CSA S6 and the MTO Structural Manual, including construction loads imposed on the bridge based on the method of construction. A synopsis of the evaluation, including detailed calculations and notes, shall be prepared and, when requested, be made available to the Contract Administrator. The documents shall bear the seals and signatures of both the evaluation Engineer and the design-checking Engineer. Documentation of such evaluation shall be retained for a period of 6 years after the Contract Administrator has issued a Certificate of Completion.

911.04.02.03.02.01 Construction Load Limits

a) Slab on Girder Structures

   i. 400 kg per support point with a maximum of two support points loaded per girder per span, or
   ii. The specified uniformly distributed load per linear metre of the girder.

b) Truss or Arch Structures

   i. 400 kg per panel point with a maximum of two panel points loaded on a truss or arch, or
   ii. The specified load per panel point.

911.04.02.04 Product Data Sheets

Product data sheet submissions shall include the manufacturer's product data sheets showing the following:

a) Recommended maximum dry film thickness.

b) The mixing and thinning directions.

c) The recommended spray nozzles and pressures.

d) The recommended temperature range and acceptable humidity levels for application.

e) The minimum acceptable recoat time period for temperatures in the intervals of 5 °C from 0 to 30 °C.

911.04.02.05 Material Certification

911.04.02.05.01 Coating Manufacturer's Certification

Before commencement of the coating application, the Contract Administrator shall be supplied with written certification from the coating manufacturer stating that all materials supplied are as specified in the Contract Documents and the manufacturer's current product data sheets.

911.04.02.05.02 Certification of Abrasive Media

Prior to abrasive blasting, the Contract Administrator shall be supplied with written certification from a laboratory certified by an organization accredited by the Standards Council of Canada stating that the abrasive media meets the material requirements specified in this specification.

911.05 MATERIALS

911.05.01 Paint Coatings

Paint coating shall be according to OPSS 1704 and as specified in the Contract Documents.

Only paint coatings contained in the original containers sealed by the manufacturer shall be used.

911.05.01.01 Seal Coat

The seal coat shall be as specified in the Contract Documents.

911.05.01.02 Paint Coating Systems for Coating Galvanized Surfaces

When specified in the Contract Documents, one of the approved paint systems for coating galvanized surfaces listed on the MTO DSM shall be applied to hot dipped galvanized components that require subsequent paint coating.

The colour of the finish coat shall be equivalent to 16307 Grey according to Federal Standard 595C Colors, unless otherwise specified.

911.05.01.03 Rapid Deployment Coating Systems for Structural Steel

When specified in the Contract Documents, one of the approved paint systems for rapid deployment coating systems listed on the MTO DSM shall be applied to structural steel.

911.05.02 Metal Coatings

911.05.02.01 Hot Dip Galvanizing

Purity of the zinc and the galvanizing bath composition for hot dip galvanizing of structural steel shall be according to ASTM A123M.

Material for repair of galvanized surfaces shall be either zinc-tin-copper solder for repair by soldering or metallizing wire for repair by metallizing.

In addition to the above materials, the use of the following paint coatings is permitted for repair of galvanized surfaces on new structural steel sign support structures and sectional steel high mast lighting poles:

a) For the repair of overhead trusses by paint coating, all three coats of the epoxy-zinc/epoxy/polyurethane system shall be listed on the MTO DSM. The colour of the finish coat shall be equivalent to 17178 aluminum according to Federal Standard 595C Colors.

b) For the repair of sign support columns and sectional steel high mast lighting poles that are specified to receive a subsequent paint coating, epoxy-zinc primer shall be listed on the MTO DSM.

911.05.02.02 Thermal Sprayed Metal Coatings

Thermal sprayed metal coatings shall be according to SSPC-CS 23.00/AWS C2.23M/NACE No.12. The metallizing wire shall be an alloy consisting of 85% zinc and 15% aluminum that conforms to the requirements of ASTM B833.

911.05.02.03 Zinc-Tin-Copper Solder

The zinc-tin-copper solder shall be 50% zinc, 49% tin, and 1% copper used with the manufacturer's recommended flux.

911.05.03 Abrasive Media

911.05.03.01 General

Abrasive media shall have a conductivity not exceeding 1,000 micro Siemens (µS)/cm, when tested according to ASTM D4940.

Except for abrasive blast cleaning of galvanized surfaces, the abrasive media shall have a hardness of 6 or greater on the Mohs scale. There shall be no presence of oil.

The testing for hardness and presence of oil shall be according to SSPC-AB 1.

The maximum moisture shall be 0.5% by weight, when tested according to ASTM C566.

911.05.03.02 Thermal Sprayed Metal Coatings

Blast abrasive media used for the surface preparation for thermal spray metal coating application shall be sufficiently hard and sharp to produce an angular surface profile on to the steel substrate such that the subsequent metal coating shall meet the bond strength requirements specified. Shot or other abrasives producing a rounded or peened profile shall not be used.

911.05.03.03 Paint Coating on Galvanized Surfaces

The abrasive media used for surface preparation of galvanized surfaces prior to receiving paint coating shall be of such hardness that the galvanized coating is not damaged.

911.05.04 Compressed Air

Compressed air used during all work operations shall be clean, dry, and free from oil residues, when tested according to ASTM D4285.

911.06 EQUIPMENT

911.06.01 Scaffolds

The coated areas of the structure coming into contact with rollers, clamps, and other parts of the scaffolding and access facilities shall be protected using rubber or other material to prevent damage to the coating.

911.06.02 Spray Pot

The agitators in the spray pot shall extend to within 25 mm of the bottom of the pot to ensure proper mixing of paint components prior to spray application.

911.07 CONSTRUCTION

911.07.01 General

The extent of work, cleaning requirements, surface preparation, environmental protection requirements, and type of coating system shall be as specified in the Contract Documents.

Where there is a conflict between the manufacturer's recommendations and the Contract Documents, the more stringent requirements shall apply as determined by the Contract Administrator.

All components coated off-site shall be protected from handling or shipping damage by using padded slings, separators, and tie downs or other similar devices. Loading procedures shall be designed to protect coated surfaces from any possible damage to the coating.

Components of structural steel sign support structures and sectional steel high mast lighting poles that are to be hot dip galvanized shall be according to the Contract Drawings. Components of structural steel sign support structures and sectional steel high mast lighting poles that are to be hot dip galvanized and subsequently paint coated shall be according to the Contract Drawings.

The Contract Administrator shall be granted access to the galvanizing and painting shops where components are being cleaned and coated, during all hours of work.

911.07.02 Operational Constraints

The Contract Administrator shall be informed when the surface preparation and each subsequent phase of work of coating application are completed and ready for inspection. Subsequent work shall not commence until the Contract Administrator has completed the inspection of the work completed and given permission in writing to proceed.

Welding, cutting, or drilling of existing structural steel shall not be done unless approved by the Contract Administrator.

All structural rehabilitation work shall be completed prior to commencing the coating operations.

Surfaces adjacent to areas to be cleaned and coated shall be protected from damage during surface preparation and coating application.

When there is partially completed coating work at seasonal shutdown, the following operations shall be carried out immediately prior to commencement of coating application in the next construction season:

a) Areas that have been coated but have not received the finish coat shall be power washed using potable water and allowed to dry thoroughly.

b) Partially completed coating exhibiting rust or rust stains shall be removed, and the surface shall be cleaned to the original surface preparation standard as specified in the Contract Documents and re-coated with the specified coating system or an alternative coating system acceptable to the Contract Administrator.

911.07.03 Surface Preparation and Surface Profile

911.07.03.01 General

Fins, slivers, burred or sharp edges, weld spatter; or slag shall be removed by power grinding prior to the surface preparation and coating application. Edges of all structural steel specified to be cleaned and coated shall be ground to a smooth radius of at least 3 mm by hand or power tools prior to abrasive blast cleaning.

Final surface preparation for coating application shall only be carried out when the temperature, moisture, and humidity satisfy the criteria specified in SSPC-PA 1 for coating application.

The temperature, moisture, and humidity limitations do not apply to interim surface preparation. The Contract Administrator shall be notified of the intention to do interim surface preparation work prior to commencement of the work.

911.07.03.02 New Structural Steel

New structural steel specified to be cleaned and paint coated shall be abrasive blast cleaned to the requirements of SSPC-SP 10/NACE No. 2. The abrasive blast cleaning shall provide a surface profile height of a minimum of 40 µm and a maximum of 75 µm.

911.07.03.03 Existing Structural Steel and Railing System

Existing structural steel that has been specified to be cleaned and paint coated in the Contract Documents, shall be abrasive blast cleaned to the requirements of SSPC-SP 10/NACE No. 2. The abrasive blast cleaning shall provide a surface profile height of a minimum 40 µm and a maximum of 90 µm for paint coating application.

The steel components in the handrail panels shall be cleaned to the requirements of SSPC-SP 8. The steel components in the posts, caps, and panel anchorages on steel posts shall be abrasive blast cleaned to the requirements of SSPC-SP 5/NACE No.1. The abrasive blast cleaning shall provide a surface profile height of a minimum of 50 µm and a maximum of 100 µm for thermal sprayed metal coating application.

The steel panel anchorages on concrete posts shall be abrasive blast cleaned to the requirements of SSPC-SP 10/NACE No.2.

911.07.03.04 Paint Coating on Galvanized Surfaces

Galvanized surfaces to be paint coated shall be prepared according to ASTM D6386.

Thick edges due to excess liquid zinc run-off during the galvanizing process; high spots; and rough edges, such as metal drip line, shall be removed by clean hand or power tools to ensure smooth surface. The excess zinc shall be removed until it is flush with the surrounding area. Any oil or grease on the surface shall be removed by solvent cleaning according to SSPC-SP 1. Surface preparation shall be performed by sweep blasting to roughen the surface using an abrasive of such hardness that the galvanized coating is not damaged.

After sweep blasting and prior to the application of the paint coating, the galvanized surface shall be examined and repaired, as required. The dry film thickness of the zinc coating after sweep blasting shall be according to ASTM A123M.

911.07.03.05 Thermal Sprayed Metal Coating

Structural steel surfaces specified to receive a thermal sprayed metal coating shall be abrasive blast cleaned to the requirements of SSPC-SP 5/NACE No.1. The abrasive blast cleaning shall provide a surface profile height of a minimum of 50 µm and a maximum of 100 µm.

911.07.03.06 Hot Dip Galvanizing

Existing structural steel specified to be hot dip galvanized shall be first abrasive blast cleaned to SSPC SP 6/NACE No.3 to remove the existing paint coatings and rust and then the components shall be cleaned to the requirements of SSPC-SP 8 prior to being galvanized.

New structural steel shall be cleaned to the requirements of SSPC-SP 8 prior to galvanizing.

The length of time that all steel components are immersed in the pickling solution shall be kept to an absolute minimum to achieve the specified surface preparation condition prior to hot dip galvanizing. The galvanizer shall employ proper pickling and galvanizing procedures as precautionary measures to safeguard against embrittlement, as specified in ASTM A143M.

911.07.03.07 Faying Surfaces

Faying surfaces of existing and new structural steel components to be connected by bolts shall be cleaned to the surface preparation standard required for the coating system specified.

Faying surfaces of slip critical connections designed to receive Class A or Class B coatings shall have the same blast cleaning as was used in the tests to determine the mean slip coefficient.

911.07.03.08 Surface Preparation of Areas Difficult to Access

Surface preparation of areas specified in the Contract Documents as difficult to access shall be carried out to the extent practical from the access opening as detailed on the submission for methods, procedures, and sequence of work. The surface preparation standard for these areas shall be based on reasonable effort demonstrated in the field acceptable to the Contract Administrator.

911.07.04 Application of Coating

911.07.04.01 General

The Contract Administrator shall be notified 48 hours in advance of mixing and applying a paint coating or coating system.

When specified in the Contract Documents new atmospheric corrosion resistant steel shall be coated with a low Volatile Organic Compound (VOC) epoxy-zinc/epoxy/polyurethane system. All other steel shall be cleaned and coated with the coating system as specified in the Contract Documents.

All new A325 bolts and accompanying nut and washers used with steel specified in the Contract Documents to receive a paint coating or galvanizing shall be Type 1 and shall be galvanized.

Prepared surfaces shall have no dust prior to the application of coating.

Paint coating shall be smooth, continuous, and free of runs and sags. No pinholes or holidays of the paint coating on galvanized components shall be allowed.

911.07.04.02 Paint Coating Systems

911.07.04.02.01 General

All paint coating systems shall be stored, thinned, handled, mixed, and applied according to SSPC-PA 1 and the recommendations on the manufacturer's product data sheets.

When there is a drop in temperature after the coating has been applied, the recoat time period shall be according to the manufacturer’s product data sheets for the lower temperature.

All rivets, bolts, nuts, washers, and pitted areas shall be stripe coated with the primer and with the top coat material by brush, in addition to spray application. Stripe coating with the primer shall be carried out after the spray application of the primer. For projects where the inorganic zinc primer is specified, an epoxy-zinc primer from the same manufacturer shall be used for stripe coating. Stripe coating with the top coat material shall be carried out prior to the spray application of the finish coat. Stripe coating shall be according to SSPC-PA 11.

Bearing shoe plates or bevelled plates or both at girder locations where coating of the girders has been specified shall also be coated using the specified coating system.

For each coat of paint the initial pass of the spray gun shall be directed at the outside edges of the steelwork prior to completely coating all surfaces.

All runs and sags shall be brushed out as the application progresses.

Application related failures in coatings, as described in the Coating Failures chapter of the SSPC Painting Manual, shall be corrected prior to application of a subsequent coat and, in the case of the top coat, after the application of the top coat.

Where excessive coating thickness produces "mud cracking" in zinc rich coating materials, the coating shall be scraped back and sanded to a soundly bonded coating and the area recoated to the required thickness.

All dry spray shall be removed by sanding and the coating reapplied as specified in the Contract Documents.

911.07.04.02.02 New Structural Steel

All new structural steel including diaphragms, excluding surfaces in contact with concrete and the faying surfaces of bolted joints, shall be coated to the extent as specified in the Contract Documents.

The maximum time between final surface preparation and prime coat application inside the shop shall be 24 hours. Structural steel subjected to outdoor exposure after final surface preparation shall be prime coated within ten hours.

All coats of the specified paint coating system shall be shop applied.

Prior to assembly, surfaces not in contact with other steel surfaces, but that are inaccessible after assembly shall have all coats applied.

Surfaces inaccessible for coating after installation shall be coated prior to installation.

At least 100 mm of bare metal and 100 mm of each coat of the new system shall be left exposed for lapping of subsequent coats, where the continuous application of paint or final surface preparation is interrupted in a section.

911.07.04.02.03 Existing Structural Steel

Except for metallizing and hot dip galvanizing, the maximum time between final surface preparation and the prime coat application shall be ten hours.

When work operations require bolt connections of structural steel components, faying surfaces of existing structural steel shall have only the prime coat applied, prior to assembly.

When tying into existing coatings, that portion of the existing coating within 300 mm of the edge of the new coating shall be power washed using potable water to remove all contaminants. The edges of the existing coating shall be feathered into areas cleaned to bare steel so that at least 4 mm of each coat of the existing coating is exposed.

911.07.04.02.04 Paint Coating on Galvanized Surfaces

All coats of the paint system shall be shop applied.

When surface preparation is done indoors and the galvanized steel component remains indoors at all times until coating is completed, the maximum time allowable between surface preparation by sweep blasting and prime coat application shall be 24 hours provided that the relative humidity within the shop is maintained at 50% or below 50% for the entire 24-hour period. If the prepared galvanized steel component is exposed outdoors or if it is kept indoors and the relative humidity is above 50%, the maximum time between final surface preparation by sweep blasting and prime coat application shall be four hours.

911.07.04.02.05 Faying Surfaces

Faying surfaces of bolted connections shall have only the prime coat applied.

Exterior surfaces of the bolted connections within a distance of 25 mm around the edge of the bolt holes and against which the bolt head or washer is going to be bearing shall receive only the prime coat. Any exposed areas of primer not covered by the bolt head or washer after the installation of the bolts shall be touched up with the second and third coats of the specified coating system.

Faying surfaces left exposed to UV radiation for extended periods of time may begin to chalk. Necessary precautions shall be taken to prevent chalking if bolted connections will not be assembled within 3 months.

If chalking is present at the time of assembly, it shall be removed by washing the surface with an appropriate cleaner and rinsing with clear water, or as recommended by the coating manufacturer.

911.07.04.02.06 Slip Critical Connections

Faying surfaces of slip critical connections designed to receive Class A or Class B coatings shall have the same coating application as was used in the tests to determine the mean slip coefficient. Slip critical connections shall not be assembled before the coating has cured for the minimum time that was used in the qualifying tests and identified in the coating manufacturer's written instructions.

At slip critical connections on paint coated components, the surface within the bolt pattern and for a distance of 50 mm beyond the splice plates shall receive only the prime coat of paint, prior to assembly. Prime coated surfaces that are exposed after assembly shall receive the second and third coats of the paint system after cleaning of the surfaces according to manufacturer's recommendations.

Faying surfaces of galvanized components of slip critical connections shall be roughened either by hand wire brushing or by sweep blasting prior to assembly to provide the required frictional resistance as specified in the Contract Documents. These faying surfaces shall not be subsequently paint coated.

911.07.04.02.07 Dry Film Thickness

Dry film thickness shall be as listed in the DSM. If not listed in the DSM, dry film thickness shall be according to the following:

An epoxy-zinc, water-based acrylic, water-based acrylic coating system shall consist of three coats with dry film thickness according to Table 1.

An epoxy-zinc, epoxy, polyurethane coating system shall consist of three coats with dry film thickness according to Table 2.

An inorganic-zinc, water-based acrylic, water-based acrylic coating system shall consist of three coats with dry film thickness according to Table 3.

An inorganic-zinc, epoxy, polyurethane coating system shall consist of three coats with dry film thickness according to Table 4.

Three-coat moisture-cured polyurethane (MCU) coating system with zinc-rich primer shall consist of three coats with dry film thickness according to Table 5.

A coal tar epoxy coating system shall consist of two coats with dry film thickness according to Table 6.

High build epoxy, aliphatic polyurethane coating system for coating galvanized surfaces shall consist of two coats with dry film thickness according to Table 7.

Modified aluminum epoxy mastic, aliphatic polyurethane coating system for coating galvanized surfaces shall consist of two coats with dry film thickness according to Table 7.

911.07.04.02.08 Repair of Paint Coatings on New and Existing Structural Steel

Damaged areas of paint coated surfaces shall be prepared to the original surface preparation standard specified and by feathering the edges of sound coatings. For damaged areas of less than 100 cm^2, power tool cleaning to SSPC SP 11 may be used for surface preparation. The prepared surfaces shall be recoated with the originally applied materials, except for inorganic zinc primer, which shall be recoated with an epoxy-zinc primer from the same manufacturer. The dry film thickness of all the three coats in the repair area shall be as specified for the initial application.

911.07.04.02.09 Repair of Paint Coatings on Galvanized Surfaces

Painted galvanized surfaces where the paint coating has been damaged shall be carefully prepared by hand or power tool cleaning and the edges, including at the interface of the uncoated areas of the faying surfaces, shall be feathered. The prepared surfaces shall be recoated with the specified materials according to the manufacturer's product data sheets.

In areas where the galvanized coating beneath the paint coating is also damaged, the repair of paint coating shall be performed upon completion of the repair of galvanized coating.

911.07.04.03 Metal Coatings

911.07.04.03.01 Hot Dip Galvanizing

At least 72 hours prior to commencement of galvanizing, the Contract Administrator shall be given written notice of the intent to hot dip galvanize including a schedule for hot dip galvanizing of various components. Hot dip galvanizing done without this prior notification may be rejected.

Galvanized surfaces that are to receive a subsequent paint coating shall be identified when delivered to the hot dip galvanizer. These surfaces shall be air cooled. Passivation treatment or water quenching shall not be permitted.

Hot dip galvanizing shall be according to ASTM A123M. Hot dip galvanizing of structural bolts and steel hardware that are to be centrifuged or otherwise handled to remove excess zinc shall be according to ASTM A153M.

Girders, diaphragms, and all other structural steel components shall be handled in such a manner to ensure that the components do not get warped or distorted during or immediately after hot dip galvanizing. The lifting system during handling of girders shall consist of a spreader beam providing support to the girder being galvanized at spacing not greater than 6 m.

Web of girders shall be kept vertical during the galvanizing process and supports at spacing not greater than 6 metres shall be provided for placing of the components during cooling after galvanizing.

Two copies of the galvanizer's coating thickness readings shall be submitted to the Contract Administrator after galvanizing and prior to the installation of the component in the structure.

911.07.04.03.02 Thermal Sprayed Metal Coatings

Written notice shall be given to the Contract Administrator 48 hours in advance of the intention to carry out surface preparation and thermal metal spray coating application.

The application of thermal sprayed metal coating shall be according to SSPC-CS 23.00/AWS C2.23M/NACE No.12 to provide a coating thickness of minimum 200 µm. Thermal sprayed metal coating shall have a bond strength of minimum 4.8 MPa to the steel substrate when tested according to ASTM D4541 using either Type III or Type V self-alignment tester.

Immediately prior to metallizing, all prepared surfaces shall be cleaned by vacuuming to remove dust, debris, and other surface contaminants. At least one layer of thermal sprayed metal coating shall be applied within 4 hours of blast cleaning or before flash rusting occurs, whichever is sooner. This layer shall cover the peaks of the surface profile. Prior to applying additional sprayed metal to the specified thickness, the first layer of coating shall be visually inspected to verify that the coating surface has not become contaminated. Any contamination between coats shall be removed according to the manufacturer's instructions before any additional material is applied. The coating shall be sprayed to obtain the specified thickness, as soon as possible.

Before starting the work, a 300 x 300 mm steel sample plate similar in composition and thickness to the steel to be coated shall be submitted to the Contract Administrator. This plate shall be cleaned and sprayed on site according to the Contract Documents. The metal coating on the sample plate shall be checked by the Contract Administrator for compliance with the Contract Documents. This plate, when accepted by the Contract Administrator, shall be used as the visual standard to determine the acceptability of the thermal spray metal coating for the entire work.

All thermal metal spray applicators shall demonstrate proficiency in applying the thermal sprayed metal coating on a test patch to the satisfaction of the Contract Administrator prior to commencing full-scale application. The first 600 mm square block pattern application shall be used for this evaluation by the Contract Administrator.

The equipment shall be operated according to the manufacturer's latest written instructions, including air pressure, gun distance to work surface, and gun angle relative to the work surface.

Thermal metal spraying shall be done in a block pattern, typically 600 mm square. The sprayed metal shall overlap 50% on each pass to ensure uniform coverage. The required coating thickness shall be obtained in multiple layers. Each layer shall be applied at right angles to the previous layer. The semi-molten or molten particles of metallizing wire shall be firmly adhered to the substrate; free from lumps, chips, blisters, or loosely adhering particles; and have a fine-sprayed texture.

911.07.04.03.03 Seal Coating of Thermal Sprayed Metal Coatings

All thermal sprayed metal coated surfaces shall be seal coated within six hours after application of thermal sprayed metal coating according to SSPC-PA 1.

Contamination on thermal sprayed metal coated surfaces, including dust and moisture, shall be removed to the satisfaction of the Contract Administrator prior to the application of the seal coat. The seal coat materials shall be mixed and applied according to the manufacturer's instructions. Thinning shall not be done, unless approved in writing by the manufacturer and by the Contract Administrator.

The minimum dry film thickness shall be 100 µm.

911.07.04.03.04 Repair of Hot Dip Galvanizing

The Contract Administrator shall be notified 24 hours in advance of their intention to carry out the repair of damaged coatings.

Damaged and uncoated areas in galvanized coating shall be repaired, only if the cumulative total of the damaged and uncoated areas does not exceed 2% of the total area of a fabricated assembly or 0.02 m², whichever is smaller. If the cumulative total of the damaged or uncoated area exceeds the above, then the damaged coating shall be stripped and the component re-dipped in a galvanizing bath according to ASTM A123M.

Damaged and uncoated areas shall be cleaned of all rust and other contaminants and repaired using one of the following methods:

a) Soldering Method Using Zinc-Tin-Copper Solder

   The surface preparation of damaged and uncoated areas and the application of the flux and zinc-tin-copper solder shall be according to ASTM A780M and the manufacturer's recommendations. The finished thickness of the metal coating in the repaired area shall be a minimum of 90 µm. The repaired surface shall be ground flush with the surrounding galvanized coating.

   For components that are to be subsequently paint coated, repair by soldering shall be performed prior to surface preparation for paint coating application.

b) Thermal Metal Spraying

The surface preparation and application of thermal spray metal coating shall be done according to SSPC-CS 23.00/AWS C2.23M/NACE No.12 to provide a thickness of minimum 200 µm, applied in two separate coats.

The metal coating on the repaired areas shall have an adhesion of minimum 2.8 MPa when tested according to ASTM D4541 using either Type III or Type V self alignment tester.

When metallizing is to be used for repair of damaged galvanized coating of structural components that are to be subsequently painted, it shall be performed immediately after the surface preparation of the repair area to the specified surface preparation standards and sweep blasting of the entire component, prior to the application of the prime coat of the paint coating system. The prime coat of the paint coating system shall be applied within six hours of repair by metallizing.

c) Epoxy-Zinc/Epoxy/Polyurethane Paint System

This method of repair of metal coating is permitted on sign support structures and sectional steel high mast lighting poles when:

i. The individual damaged and uncoated area with exposed steel is less than 625 mm^2,
ii. The dry film thickness of the galvanized coating of a structural member in localized areas does not meet the specification requirements but exceeds 60 µm, and
iii. The number of repair spots does not exceed six per galvanized overhead truss or a column or a section of sectional steel high mast lighting pole.

All three coats given for the system listed on the MTO DSM shall be used for repair of galvanized coating defects on overhead trusses.

Only the epoxy-zinc primer listed on the MTO DSM shall be used for repair of galvanized coating defects in sign support columns and sectional steel high mast lighting poles. Defects shall then be top coated with the same paint coating system used for top coating of the structural component.

Surface preparation of the damaged or uncoated areas shall be by hand or power tool cleaning using clean equipment, scraping of the edges of galvanized coating to remove loose edges, feathering of the edges of intact coatings, and abrading of surface followed by solvent cleaning according to SSPC-SP 1. Where coating damage has exposed the base metal and the width is larger than 6 mm, the damaged area shall be cleaned according to SSPC-SP 11 prior to the application of the epoxy-zinc primer.

All paint coating materials shall be brush applied according to manufacturer's product data sheets.

When paint coated galvanized surfaces are damaged, the paint coating on and around the galvanized surfaces that are to be repaired shall be removed by sanding to a sufficient distance from the repair area to prevent heat damage to the paint during metal coating repair process, followed by repair of damaged metal coating. The specified paint coating system shall then be applied over the repaired area according to manufacturer's product data sheets.

911.07.04.03.05 Repair of Thermal Sprayed Metal Coatings and Seal Coat

The Contract Administrator shall be notified 24 hours in advance of their intention to carry out the repair of damaged coatings.

Damaged metal coating and uncoated areas of structural steel surfaces shall be cleaned of all rust and other contaminants and repaired by thermal metal spraying according to SSPC-CS 23.00/AWS C2.23M/NACE No.12 to provide a thickness of minimum 200 µm, applied in two separate coats. The surfaces shall be brought to the original surface preparation standard specified prior to thermal metal spraying.

For repair of seal coated metallized surfaces, the seal coating on and around the metallized surfaces that are to be repaired shall be removed by sanding to a sufficient distance from the repair area to prevent damage to seal coating during the metal coating repair process. The repaired area shall then be coated with the specified seal coating system according to the Seal Coating of Thermal Sprayed Metal Coatings clause.

911.07.04.04 Coating of Areas Difficult to Access

Coating of areas specified in the Contract Documents as difficult to access shall be done from the access opening, as detailed in the submission for methods, procedures, and sequence of work. Quality of coating application for these areas shall be based on reasonable effort demonstrated in the field acceptable to the Contract Administrator.

911.07.04.05 Existing Steel Railing Systems

911.07.04.05.01 General

Steel handrail panels shall be removed from the structure, delivered to the galvanizer, cleaned and prepared, galvanized, delivered to the site, and reinstalled.

Steel posts, steel post caps, and steel panel anchors shall be metallized after removal of and prior to reinstallation of the handrail panels.

The structural steel in the steel panel anchorages on concrete posts shall be coated with the low VOC epoxy-zinc/epoxy/polyurethane system.

911.07.05 Field Sampling and Testing of Coating Materials

911.07.05.01 Paint Coating Materials

Field samples of 250 ml of each batch of each component of all paint coating materials used shall be obtained for testing.

For multicomponent paint coat, there shall be enough samples of each paint component so that different batches could be combined to form the complete coat for testing.

The coating supplier shall be consulted for the sampling procedure prior to obtaining samples of moisture sensitive materials. Solvent shall not be added to the field samples. Containers for field samples shall be supplied by the Contract Administrator.

The following information on coating samples shall be provided:

Product Name and Code:
Component information:
Product Batch #:
Contract #:
Location and name of the structure:
Sampling date:
The contact info for the person sampling the coating material:
(Company name, their name, email address, and phone number)

Field samples shall be delivered within 1 week from the date of sampling for testing to a laboratory designated by the Owner.

911.07.05.02 Metallic Coating Materials

When the application of thermal sprayed metal coating is specified in the Contract Documents, a 1.0 m long metallizing wire from the same batch used in the work shall be submitted to the Contract Administrator.

911.07.06 Access for Inspection

Access for inspection to all portions of the work shall be provided and maintained.

911.07.07 Quality Control

Ongoing quality control of the cleaning and coating application operations, including measurements of temperature, humidity, dew point, surface profile, and coating thickness shall be performed. Quality control measurements shall also include monitoring of the air change and the existence of negative pressure within the enclosure for projects that require surface preparation by abrasive blast cleaning or other high dust generating methods. The existence of negative pressure within the enclosure by instrument measurements or by visual assessment shall be demonstrated as often as requested by the Contract Administrator. Written documentation of measurements taken, including dry film thickness (DFT) measurements taken using Type 2 constant pressure probe magnetic gauges, shall be provided to the Contract Administrator on a weekly basis, minimally, or more often as requested by the Contract Administrator. Dry film thickness readings for quality control shall be measured according to ASTM D7091 using a Type 2 magnetic gauge.

The magnetic gauge shall be calibrated according to the procedures in SSPC-PA 2. To facilitate the calibration procedure, a 75 x 75 mm area of the prepared steel at a location selected by the Contract Administrator shall be masked off. After all tests are completed, this area shall be coated as specified in the Contract Documents. As an alternative to calibrating the Type 2 magnetic gauge on the prepared surface, an uncoated 300 x 300 mm reference plate sample of steel of similar composition; thickness, $\pm$ 10%; and surface preparation may be provided for gauge calibration.

911.07.08 Environmental Protection During Surface Preparation and Coating of Structural Steel and Steel Railing Systems

911.07.08.01 General

During the work of surface preparation and coating of structural steel and steel railing systems, the total cumulative time of random escapes to the environment shall not exceed 15 minutes over an eight hour work shift. For shorter or longer work shifts, the allowable cumulative time of escape shall be prorated by proportioning, based on the duration of the work shift to 8 hours.

Operation shall cease immediately in the event that the random escapes exceed the specified limits or any escape extends beyond the right-of-way.

Operation shall not resume until remedial action and cleanup has been completed.

911.07.08.02 Application of Coating Material Without Spray Equipment

When coating material is applied without spray equipment, an enclosure is not required, provided escape of coating material is prevented. A method of containment shall be provided to protect the surrounding areas from unwanted spills and drips of paint coating materials.

911.07.08.03 Application of Coating Material with Spray Equipment

When coating material is applied with spray equipment, a full enclosure that prevents the escape of coating material shall be installed and maintained.

911.07.08.04 Low Dust Generating Surface Preparation

Partial enclosures may be used to prevent escape of material, including substrate material, paint chips, and localized dust, from low dust generating surface preparation methods such as cleaning with hand or power tools.

911.07.08.05 Abrasive Blasting or Other High Dust Generating Surface Preparation

911.07.08.05.01 General

Except as specified below for the vacuum abrasive blasting and filtration or similar vacuum and filtration systems, a full enclosure with a negative pressure system shall be installed and maintained around all surface preparation activities when abrasive blasting is carried out.

911.07.08.05.02 Vacuum Abrasive Blasting

At work areas where vacuum abrasive blasting is used, a full enclosure with negative pressure system is not required, provided the vacuum blasting equipment can satisfy the random escape limits stipulated in this specification. A partial enclosure with ground covers and skimmers on waterways shall be installed as a minimum to prevent incidental escape.

911.07.08.06 Enclosures

911.07.08.06.01 General

Enclosures shall be installed, operated, and maintained to limit the random escape of material.

When openings or tears occur in the enclosure, surface preparation operations shall cease until repairs have been made.

The enclosures shall be removed from the right-of-way at the completion of the work.

Work platforms and the ground surface, where work is being conducted from the ground, shall be covered with tarps with overlapping sealed edges or other means to protect the ground from contamination and to permit recovery of the spent material.

Deck drains shall be fully sealed when the deck surface forms the floor of the enclosure. Where the enclosure extends below the deck, deck drains shall be temporarily extended or redirected to avoid road run off discharging into the enclosure.

There shall be no escape of dust or materials while dismantling or moving the enclosure. Walls, floors, and joints of the enclosure shall be cleaned by vacuuming prior to moving or dismantling it. All dust and material not previously accessible or found in cracks and joints during dismantling shall be immediately vacuumed.

911.07.08.06.02 Partial Enclosures

Partial enclosures shall be installed to prevent the escape of all materials, including localized dust.

A partial enclosure is not an appropriate containment system for high dust generating surface preparation operations such as abrasive blast cleaning. Partial enclosures may consist of vertical and floor tarps, provided the tarps are overlapped and securely fixed together at the seams.

911.07.08.06.03 Full Enclosure

Full enclosures shall be impervious to dust and wind and prevent the escape of all materials, including dust. A full enclosure on its own is not an appropriate containment system for high dust generating surface preparation operations such as abrasive blast cleaning. Full enclosures shall be free of any openings and shall have joints, seams, and overlaps fully sealed.

911.07.08.06.04 Full Enclosure with Negative Pressure

A full enclosure with negative pressure shall consist of the full enclosure, as described in the Full Enclosures clause, equipped with a mechanical ventilation system capable of effecting complete air change for the enclosure in less than 1 minute. The mechanical ventilation system shall be in operation during abrasive blast cleaning, clean up activities, and surface blow down or other high dust generating surface preparation operations to ensure effective removal of dust and other materials from the air inside the enclosure.

911.07.08.07 Dust Collector

Air evacuated from an enclosure shall be conveyed in fully sealed conduits to a dust collector appropriately sized for the material and airflow. There shall be no escape of materials from conduits and dust collectors.

911.07.08.08 Recycling Equipment

When spent abrasive material is recycled, there shall be no escape of dust or material during the mobilization, operation, clean-up, or demobilization of abrasive recyclers, conduits, dust collectors, and associated equipment. The collectors and filters should arrive on site undamaged, empty, and free of all dust and debris.

911.07.08.09 Handling and Storage of Spent Material

Spent materials and dust in the immediate vicinity of the area where structural steel is to be coated shall be removed prior to paint coat application. Spent materials from an enclosure shall be collected daily. Spent material from recycling equipment and dust collectors shall be collected on a regular basis to maintain the effective performance of the equipment. All spent material shall be stored in rigid containers with tight sealing lids. The containers shall be made of steel, rigid plastic, or similar material and shall be in sound condition. The containers shall keep the material dry at all times and prevent its escape. There shall be no escape of material during transfers to and from containers, enclosures, recycling equipment, or dust collectors.

Measures shall be taken to prevent vandalism of stored spent material.

911.07.08.10 Containment around Equipment and Materials

If any equipment or materials are stored on the bridge deck, approaches, or adjacent surfaces, the surfaces under such equipment shall be covered with tarps to contain any spills or leaks from the equipment or operations involving the equipment.

Tarps shall be sufficiently overlapped, impervious to water, and free of holes and openings.

All spills accumulated on the tarps shall be prevented from escaping onto the surrounding surface and be cleaned up immediately.

911.07.08.11 Remedial Work

Remedial work related to the environmental protection shall be carried out to rectify work that does not meet the requirements as specified in the Contract Documents. A remedial work scheme shall be submitted to the Contract Administrator and work shall not proceed until written permission to do so is received from the Contract Administrator.

911.07.09 Management of Excess Materials

Management of excess materials shall be according to the Contract Documents.

911.08 QUALITY ASSURANCE

911.08.01 Inspection

Each phase of the work shall be inspected by the Contract Administrator and approved before work is to commence on to the next phase.

911.08.02 Surface Preparation

Acceptability of the surface preparation by the Contract Administrator shall be based on the applicable SSPC surface preparation specifications and pictorial standards given in SSPC-VIS 1 and SSPC-VIS 3.

911.08.03 Measurement of Surface Profile

Surface profile measurements shall be made by the Contract Administrator on a random basis using a spring micrometer and an extra coarse pressure sensitive replica tape according to ASTM D4417, Method C.

911.08.04 Testing for Cleanliness

The work shall be randomly tested by the Contract Administrator for cleanliness to determine contamination of surfaces by the presence of visible dust, oils, grease, or other foreign matter.

911.08.05 Measurement of Temperature, Humidity, and Dew Point

Random testing of ambient and surface temperature, relative humidity, and dew point by the Contract Administrator shall be done by means of a thermometer, surface thermometer, or recording hygro-thermograph and digital or sling psychrometer with recognized psychometric tables.

911.08.06 Measurement of Coating Thickness

Measurement of the coating thickness shall be made by the Contract Administrator. The dry film thickness shall be measured according to ASTM D7091 using a Type 2 magnetic gauge.

Determination of the acceptability of the dry film thickness of each coat shall be made according to SSPC-PA 2, Coating Thickness Restriction Level 3.

The specified maximum dry film thickness used to determine acceptability of coating thickness according to SSPC-PA 2 shall be the manufacturer's recommended maximum, as shown in the submitted product data sheets.

The Contractor shall be present when the Owner's magnetic gauges are being calibrated by the Contract Administrator.

911.08.06.01 Measurement of Coating Thickness on New Structural Steel Sign Support Structures and Sectional Steel High Mast Lighting Poles

The dry film thickness shall be measured by Type 2 constant probe magnetic gauges according to ASTM D7091 and SSPC-PA 2, except that five separate spot measurements at representative locations of each galvanized sign support columns or legs and each sectional steel high mast lighting pole shall be taken after the application of individual coats of the paint coating system.

911.08.07 Testing Adhesion of Paint Coatings

Paint coatings may be tested for adhesion at the discretion of the Contract Administrator.

911.08.08 Testing Adhesion of Thermal Sprayed Metal Coatings

During thermal metal spraying, the Contract Administrator shall perform random adhesion tests according to ASTM D4541 using either Type III or Type V self alignment tester. The minimum acceptable adhesion strength shall be 4.8 MPa. All non-conforming areas and areas damaged by the test shall be re-blasted and re-sprayed to conform to the requirements as specified in the Contract Documents.

Adhesion measurements on repaired areas may be made on a random basis according to the above method.

911.08.09 Testing of Coating Materials

The submitted field samples of paint coatings shall be tested according to OPSS 1704 and as specified in the Contract Documents. Samples of metallic coating materials shall be tested as specified in the Contract Documents.

911.08.10 Frequency of Tests and Inspection

Except as specified above, the frequency of tests shall vary as conditions require.

911.08.11 Performance Warranty for Coating of Existing Structural Steel

When the area of existing structural steel to be cleaned and coated is more than 200 m^2, the coating system shall be unconditionally warranted for a period of 24 months from the date of the Contract Completion Certificate that it has been applied as specified in the Contract Documents, and will be free from defects, as specified below.

The coating system shall be considered defective if any of the following conditions exist:

a) Visible corrosion products, except at locations defined in the Contract Documents as difficult to access, blistering, bubbling, checking, cracking, wrinkling, delaminations, dry spray, pinholes, sagging, flaking, mud cracking, peeling, scaling, or undercutting.

b) Coating applied over dirt, debris, blasting debris, corrosion products not removed during surface preparation, or steel projections.

c) Incomplete coating.

d) Damage to the coating caused by the Contractor's operations or excessive blast dust on the finish coat.

In the two months immediately preceding the last month of the warranty period, the Owner shall inspect the coatings for the defects listed above. The Contractor shall be given a minimum of 72 hours' notice prior to the inspection and may be present during this inspection. The Owner at his expense shall arrange for traffic control and access for the inspection.

All defective areas identified by the inspection shall be repaired as specified in the Contract Documents. All repair work shall be completed within 8 weeks of the Contractor receiving notification of the results of the inspection, unless prevented by seasonal shutdown, in which case the repairs shall be completed in the first 5 weeks of the following construction season.

911.10 BASIS OF PAYMENT

911.10.01 Coating Existing Structural Steel - Item
Coating New Structural Steel - Item
Coating Steel Railing System - Item
Environmental Protection During Coating of Structural Steel and Steel Railing Systems - Item
Coating New Structural Steel Sign Support Structures - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Remedial work on environmental protection shall be completed by the Contractor at no additional cost to the Owner.

911.10.02 Progress Payments

911.10.02.01 Coating Items

Progress payments for the coating items shall be made on the following basis:

a) Coating Existing and New Structural Steel

i. Paint Coatings:

Surface preparation and prime coat	80% for two coat systems 70% for three coat systems
2nd coat	15% for two coat systems 10% for three coat systems
3rd coat	15% for three coat systems
Cleanup and final coating repair	5%

ii. Hot Dip Galvanizing and Hot Dip Galvanizing with Paint Coatings:

Surface preparation and hot dip galvanizing	90% for hot dip galvanizing only application 55% for hot dip galvanizing with paint coatings
Sweep blasting and all coats of paint coating	35%
Cleanup and final coating repair after installation	10%

iii. Thermal Sprayed Metal Coating with Seal Coat:

Surface preparation, metallizing, and seal coat	90%
Cleanup and final coating repair	10%

b) Coating Steel Railing System:

Dismantling, delivery to galvanizer, surface preparation, galvanizing, and coating of posts and anchors	80%
Delivery to site and installation	15%
Cleanup and final coating repair after installation	5%

911.10.02.02 Environmental Protection Items

Progress payments for environmental protection shall be made on the same percentage basis as the coating items for which the environmental protection is required.

TABLE 1
Epoxy-Zinc, Water-Based Acrylic, Water-Based Acrylic Coating System

Coat	Dry Film Minimum Thickness µm
Prime Second Third	90 90 90

TABLE 2
Epoxy-Zinc, Epoxy, Polyurethane Coating System

Coat	Dry Film Minimum Thickness µm
Prime Second Third	90 100 50

TABLE 3
Inorganic-Zinc, Water-Based Acrylic, Water-Based Acrylic Coating System

Coat	Dry Film Minimum Thickness µm
Prime Second Third	75 90 90

TABLE 4
Inorganic-Zinc, Epoxy, Polyurethane Coating System

Coat	Dry Film Minimum Thickness µm
Prime Second Third	75 100 50

TABLE 5
Three-Coat Moisture-Cured Polyurethane Coating System with Zinc-Rich Primer

Coat	Dry Film Minimum Thickness µm
Prime Second Third	90 100 50

TABLE 6
Coal Tar Epoxy Coating System

Coat	Dry Film Minimum Thickness µm
Prime Second	200 200

TABLE 7
Paint Coating Systems for Coating Galvanized Surfaces

Coat	Dry Film Minimum Thickness µm
High Build Epoxy Prime Coat Aliphatic Polyurethane Topcoat	100 75
Modified Aluminum Epoxy Mastic Prime Coat Aliphatic Polyurethane Topcoat	125 50

Appendix 911-A, November 2022
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Type of paint coating system to be applied. (911.05.01)

- Type of seal coating system to be applied. (911.05.01.01)

- Galvanized surfaces to be paint coated. (911.05.01.02)

- Structural steel surfaces to be paint coated. (911.05.01.03)

- Extent of work, cleaning requirements, surface preparation, environmental protection requirements, type of coating system. (911.07.01)

- Components of structural steel support structures and sectional steel high mast lighting poles to be hot dip galvanized. (911.07.01)

- Components of structural steel sign support structures and sectional steel high mast lighting poles to be hot dip galvanized and subsequently paint coated. (911.07.01)

- Original surface preparation standard. (911.07.02)

- Difficult to access areas. (911.07.03.08)

- New atmospheric corrosion resistant steel to be coated with a low VOC system. (911.07.04.01)

- Required frictional resistance of slip critical connections. (911.07.04.02.06)

- Management of excess materials. (911.07.09)

- Testing for submitted field samples of paint coatings. (911.08.09)

The designer should determine if the following is required and, if so, specify it in the Contract Documents:

- A tender item for environmental protection requirements. (911.04.02.03.01, 911.10.01)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

Note: The MUNI implemented in November 2017 replaces OPSS 913 COMMON, November 2014 with no technical content changes.

CONSTRUCTION SPECIFICATION FOR EMBEDDED WORK IN STRUCTURES FOR ELECTRICAL SYSTEMS

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913-A **Commentary**

913.01 SCOPE

This specification covers the requirements for the installation of electrical and communication materials to be embedded in structures.

913.01.01 Significance and Use of Appendices

This specification has been developed for use in municipal-oriented Contracts. The administration, testing, and payment policies, procedures, and practices reflected in this specification correspond to those used by many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

913.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

913.02 REFERENCES

When the Contract Documents indicate that provincial-oriented specifications are to be used and there is a provincial-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.PROV, unless use of a municipal-oriented specification is specified in the Contract Documents. When there is not a corresponding provincial-oriented specification, the references below shall be considered to be to the OPSS listed, unless use of a municipal-oriented specification is specified in the Contract Documents.

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 603	Installation of Ducts
OPSS 616	Footings and Pads for Electrical Equipment

CSA Standards

C22.2 No. 85-14	Rigid PVC Boxes and Fittings
C22.2 No. 40-M1989 (R2009)	Cutout, Junction, and Pull Boxes
C22.2 No. 211.2-06 (R2011)	Rigid PVC (Unplasticized) Conduit
C22.2 No. 227.1-06 (R2011)	Electrical Nonmetallic Tubing

913.05 MATERIALS

913.05.01 Junction Boxes and Fittings

Junction boxes and fittings shall be according to CSA C22.2 No. 85.

913.05.02 Rigid Ducts

Rigid ducts to be embedded shall be according to OPSS 603, Table 1.

Ducts less than 60 mm diameter shall be rigid PVC and according to CSA C22.2 No. 211.2. The associated cleaner and solvent cement shall be according to the duct manufacturer's recommendations.

913.05.03 Flexible Ducts and Fittings

Flexible ducts and fittings shall be according to CAN/CSA C22.2 No. 227.1.

913.05.04 Fish Line

Fish line shall be nylon or polypropylene materials with a minimum test strength of 400 N.

913.05.05 Anchorage Assemblies and Hardware

Anchorage assemblies and hardware shall be according to OPSS 616.

913.05.05.01 Anchor Assembly Struts

Anchor assembly struts shall be according to OPSS 616.

913.05.05.02 Studs, Nuts, and Washers

Studs, nuts, and washers shall be according to OPSS 616.

913.05.05.03 Ferrules

Ferrules shall be according to OPSS 616.

913.07 CONSTRUCTION

913.07.01 Embedded Work in Structure

All components shall be installed at locations specified in the Contract Documents. Components shall be secured and supported in place so that shifting or deflection of the components does not occur during the placing of concrete or under other such loads as may be encountered during construction.

913.07.01.01 Junction Boxes

Junction boxes shall be installed so that the outside faces of the covers are flush with the finished surface of the concrete, except for barrier walls. Junction boxes shall be recessed 50 mm in barrier walls and have grounded galvanized steel treaded covers according to CSA C22.2 No. 40 and the Contract Documents.

Junction boxes shall be drilled to accept conduit fittings as specified in the Contract Documents. Ducts and conduit fittings shall be connected to junction boxes using appropriate solvent cement.

913.07.01.02 Ducts

Ducts shall be installed using CSA approved fittings, couplings, and accessories for the type of duct used. Adapter couplings shall be installed between ducts of dissimilar materials. Expansion and deflection fitting assemblies or wobble joints shall be installed at structural expansion joints.

Expansion and deflection coupling joints shall be according to the Contract Documents and manufacturer's specifications. Duct to couplings and fittings connections shall be made with a cleaner and solvent cement suitable for the type of duct installed.

Ducts ending at vertical concrete faces shall be terminated with fittings as specified in the Contract Documents.

Ducts shall be free of debris, water, breakage, and distortion and verified by pulling a mandrel through the ducts.

All open ends in ducts shall be plugged with plastic plugs.

913.07.01.03 Fish Line

A fish line shall be installed in all duct systems. A 1.5 m length of fish line shall be left coiled in each junction box and at each duct termination at a concrete face by bringing the fish line out of the duct beside the plastic plug.

913.07.01.04 Anchorage Assemblies

Anchorage assemblies shall be installed according to OPSS 616.

913.07.02 Embedded Work in Structure for Other Than Owner

The work for embedded work in structure for other than the Owner shall be according to subsection Embedded Work in Structure and as specified in the Contract Documents.

When material supplied by others to the Contractor is specified in the Contract Documents, the Contractor shall notify the Contract Administrator in writing of the need for the material a minimum of 30 Days in advance of the date when the material is required.

913.10 BASIS OF PAYMENT

913.10.01 Embedded Work in Structure - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

Appendix 913-A, Commentary for OPSS 913, November 2017
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Locations of components for embedded work in structures. (913.07.01)

- Drilling requirements for junction boxes. (913.07.01.01)

- Fittings for conduits ending at vertical concrete surfaces. (913.07.01.02)

- Additional requirements for embedded work in structures for other than the Owner. (913.07.02)

The designer should determine if there is material supplied by the Owner or by others to the Contractor. If so, this should be specified in the Contract Documents. (913.07.02)

The designer shall incorporate embedded work in structures according to CAN/CSA S6-00, Canadian Highway Bridge Design Code.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 2101.020	Extension of Existing Rigid Ducts Encased in Concrete
OPSD 2102.01	Underground Rigid Duct Connection at Concrete Structure
OPSD 2200.070	Pole Footing in Earth for Cast-In-Place Concrete Barrier
OPSD 2200.080	Pole Footing in Rock for Cast-In-Place Concrete Barrier
OPSD 2215.02	Anchorage Assembly
OPSD 2216.010	Anchorage Assembly for Pole Footing in Concrete Barrier
OPSD 2300.010	Rigid PVC Junction Box, Type P1
OPSD 2300.020	Rigid PVC Junction Box, Type P2
OPSD 2300.030	Rigid PVC Junction Box, Type P4
OPSD 2302.010	Embedded Work Detail for Rigid PVC Junction Box, Type P3-1, for Use in Concrete Barrier Wall
OPSD 2302.020	Expansion and Deflection Fitting Assembly for 50 and 75 mm Rigid Ducts
OPSD 2302.040	Embedded Work in Structure, New Jersey Type Concrete Barrier Wall
OPSD 2456.010	High Mast Lighting Pole Anchorage Assembly Details for Double Base Plate

CONSTRUCTION SPECIFICATION FOR WATERPROOFING BRIDGE DECKS WITH HOT APPLIED ASPHALT MEMBRANE

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914-A **Commentary**
914-B **Supplemental Requirements for Using OPSS 914 in Municipal Contracts**

914.01 SCOPE

This specification covers the requirements for waterproofing of new and existing concrete bridge decks with hot applied asphalt membrane.

914.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

914.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

914.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standards Specifications, Material

OPSS 1212	Hot-Poured Rubberized Asphalt Joint Sealing Compound
OPSS 1213	Hot Applied Rubberized Asphalt Waterproofing Membrane
OPSS 1215	Protection Board

Ontario Ministry of Transportation Publications

MTO Field Guide, for the Acceptance of Hot Mix and Bridge Deck Waterproofing

Canadian General Standards Board (CGSB)

37-GP-9MA (1983)	Primer, Asphalt, Unfilled for Asphalt Roofing, Damproofing and Waterproofing

ASTM International

D 4285-83 (2006)	Test Method for Indicating Oil or Water in Compressed Air

914.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Deck means the upper concrete surface of a structure to which waterproofing membrane shall be applied.

Lot means a single bridge deck or part of a bridge deck with a surface area of 800 m^2 or less. Decks larger than 800 m^2 shall be divided into the least number of equal size lots of 800 m^2 or less. Decks split longitudinally for staged construction shall be treated as separate decks. The Contract Administrator shall determine the exact limits of each lot.

Mean means the arithmetic average of the test results for waterproofing membrane thickness within the lot.

Protection Board means a durable panel specifically designed to provide an interface protection barrier between the asphalt and the waterproofing membrane.

Random Location means a location determined by the Contract Administrator based on random numbers or, if protection boards are used, it means the exposed corner of a protection board closest to that location.

Standard Deviation means the square root of the value found by summing the squares of the difference between each test result and the mean of the test results divided by the number of test results minus one.

Sublot means the area within which membrane thickness is measured. There are 10 sublots within a lot calculated as length of lot ÷ 10 x lot width.

914.05 MATERIALS

914.05.01 Waterproofing Membrane

The waterproofing membrane shall be hot applied rubberized asphalt according to OPSS 1213 and shall be supplied to the job site in cakes in the manufacturer's sealed and labelled containers ready for melting and application.

914.05.02 Waterproofing Membrane Reinforcement

Waterproofing membrane reinforcement shall be spun bonded sheet structure composed of 100% continuous filament polyester fibres bonded together at their crossover points and shall be acceptable to the Owner. The membrane shall be supplied in minimum widths of 450 mm. The material shall be unaffected by the heat generated by the waterproofing membrane and the hot mix.

914.05.03 Hot-Poured Rubberized Asphalt Joint Sealing Compound

The hot-poured rubberized asphalt joint sealing compound shall be according to OPSS 1212.

914.05.04 Protection Board

Protection board shall be according to OPSS 1215.

914.05.05 Tack Coat

The tack coat used in conjunction with the waterproofing membrane shall be primer cut back with an equal volume of gasoline type solvent or an acceptable alternative cut-back asphalt product. The primer shall be according to CAN/CGSB-37-GP-9MA.

914.06 EQUIPMENT

914.06.01 Heating and Mixing Kettle for Waterproofing Membrane and Hot-Poured Rubberized Asphalt Joint Sealing Compound

Approved heating and mixing kettles shall be used for the waterproofing membrane and the hot-poured rubberized asphalt joint sealing compound.

The kettles shall be of the double boiler oil heat transfer type with a built-in agitator and equipped with 2 functional permanently installed dial type thermometers with an accuracy of ± 2 °C to measure the temperature of the melted compound and the oil.

914.06.02 Thermometer

A separate calibrated thermometer with an accuracy of ± 2 °C to verify the material temperature shall be available on the job site.

914.06.03 Air Compressor

The compressor shall provide oil and water free compressed air. The compressed air shall be tested according to ASTM D 4285.

914.07 CONSTRUCTION

914.07.01 General

914.07.01.01 Bridge Deck Waterproofing

Bridge deck waterproofing shall consist of:

a) Deck surface preparation.

b) Application of the tack coat.

c) Application of the waterproofing membrane.

d) Application of the protection board used with the waterproofing membrane.

e) Repair of unacceptable or borderline lots due to waterproofing membrane thickness deficiency.

f) Handling and controlling of traffic.

g) Application of the waterproofing membrane reinforcement.

h) Forming and filling of grooves where there are no separate tender items for this work.

914.07.01.02 Traffic Restrictions

After abrasive blast cleaning operations have commenced, traffic shall not be allowed on the abrasive blast cleaned area until after the hot mix binder course has been placed and cooled to ambient temperature.

The traffic restrictions apply to all traffic other than the construction equipment directly associated with the waterproofing operations and the paving operations that follow.

914.07.01.03 Procedure

Waterproofing operations shall only be carried out when the air and concrete surface temperature are 5 °C or higher. The waterproofing operations shall be performed sequentially with no delay between operations other than delays that may be required by this specification.

Drainage holes through the deck shall not be plugged or covered by either waterproofing membrane or protection boards.

914.07.01.04 Notice of Commencement of Waterproofing Operations

At least 48 hours prior to the commencement of any waterproofing operations, the Contract Administrator shall be informed, in writing, of the date and time the Contractor intends to commence the work.

Waterproofing shall not commence until permission is given by the Contract Administrator.

914.07.01.05 Existing Asphalt Covered Decks

When an asphalt riding surface is to be stripped from the existing concrete structure deck, at least 7 Days prior to the commencement of the asphalt stripping operation, the Contract Administrator shall be informed, in writing, of the date and time the Contractor intends to commence the work.

914.07.01.06 Applicators

A firm certified to apply the waterproofing membrane by the manufacturer of the product shall carry out the application of the waterproofing membrane.

914.07.02 Deck Surface Preparation

914.07.02.01 Treatment of Grout Tubes on Deck Surfaces

The grout tubes shall be cut flush with the deck surface prior to sand blasting and shall be recut flush with the concrete surface if sandblasting results in the tube projecting from above the concrete. A 450 x 450 mm piece of membrane reinforcement, centred on the tube, shall be installed as specified herein.

914.07.02.02 New Concrete Bridge Decks and Concrete Deck Overlays

The surface of the concrete shall be completely treated by abrasive blast cleaning or other such methods as the Contract Administrator may approve to expose sound laitance-free concrete. Curing compound used on the concrete surface shall be completely removed. All dirt and debris shall be removed from the bridge deck. Immediately prior to the application of the tack coat, the concrete surface shall be cleaned with a jet of oil-free compressed air to remove all dust and other foreign material.

914.07.02.03 Existing Deck Surface Preparation

All areas of the concrete deck that have a textured surface, not including sawcut grooves, shall be bush hammered, ground down, or scabbled to reduce the depth of texture to 2 mm or less prior to the abrasive blast cleaning operation for waterproofing.

Prior to waterproofing, all concrete surfaces shall be treated in accordance with the New Concrete Bridge Decks and Concrete Deck Overlays clause.

914.07.02.04 Modification of Deck Joint Assemblies of Existing Bridge Decks

Modifications to the expansion joint assemblies involving welding or other means of attachment to existing armouring shall be carried out prior to waterproofing.

914.07.02.05 Modification of Deck Drains

Modification of deck drains shall be as specified in the Contract documents. The modifications shall be made prior to waterproofing the deck.

914.07.03 Tack Coating

A tack coat shall be applied wherever waterproofing membrane is to be applied. The tack coat shall terminate in the chase or, where there is no chase, be extended up the face of the curbs, barrier walls, expansion joints, and deck drains to the level of the top of the proposed hot mix base course. The tack coat material shall be uniformly applied at the rate of 0.25 l/m^2 using equipment approved by the manufacturer of the tack coat material. The tack coat shall be applied when the concrete is surface dry and clean. Waterproofing equipment shall not be permitted upon the tack coat until it has fully cured.

Drying of the concrete surface shall not be expedited by use of a torch or any other means.

914.07.04 Application of Waterproofing Membrane

Cakes of asphalt waterproofing membrane shall be melted on the job site and shall be continuously agitated in the mechanically agitated heating and mixing kettle. The contents shall be continuously agitated until the material can be drawn free flowing and lump free from the mixing kettle at a temperature within the range recommended by the manufacturer.

Areas of the deck with sawcut grooves shall be filled with a scratch coat of waterproofing after the tack coat has cured. The waterproofing membrane shall be applied immediately after application of the scratch coat.

Waterproofing membrane shall not be applied until the tack coat has cured completely. The tack coat shall also be free of any surface moisture and dirt and it shall not be dried by torch or any other means. The waterproofing membrane shall be applied within the temperature range recommended by the manufacturer to form a uniform film having a thickness of 5 ± 1 mm. The application of the waterproofing membrane shall be continuous. If discontinuities cannot be avoided, the waterproofing membrane shall be lapped a minimum of 150 mm.

The waterproofing membrane shall terminate in the chase or, where there is no chase, be extended up the face of curbs, barrier or parapet walls, expansion joints, and deck drains to the level of the top of the proposed hot mix base course.

914.07.05 Membrane Reinforcement

The membrane reinforcement shall be placed directly over the waterproofing membrane and pressed in while it is still tacky. The membrane reinforcement shall terminate in the chase or, where there is no chase, be extended up the face of the curbs, barrier walls, expansion joints, and deck drains to the level of the top of the proposed hot mix base course. The membrane reinforcement shall then be covered with an additional layer of waterproofing membrane.

914.07.06 Application of Protection Board

Protection boards shall be laid on the waterproofing membrane while the surface is still tacky and shall be laid transverse to the centreline of the deck. Material shall not be applied to the waterproofing membrane surface to remove the tackiness prior to installation of the protection board. The protection boards shall be placed with all edges overlapping 12 ± 6 mm. The protection board edge shall be within 6 mm of all curbs, vertical faces of drains, and vertical faces of expansion joints. Protection boards shall be placed such that the joints lap in the direction of traffic flow and be staggered a minimum of 150 mm.

Binder course pavement shall be placed within 7 Days of waterproofing.

914.07.07 Form and Fill Grooves

Where hot mix asphaltic concrete is carried directly over expansion and fixed joints and where specified in the Contract Documents, a 20 mm wide and 20 mm deep rectangular groove shall be formed.

This groove shall be made either by dry sawing or routing with vertical sides and be located directly over the joint for the full length of the joint.

Immediately prior to placing the hot-poured asphaltic sealing compound, the groove shall be dry and clean of any dust or debris using oil-free compressed air.

Cakes of joint sealing compound shall be melted on the job site and shall be continuously agitated in the mechanically agitated heating and mixing kettle. The contents shall be continuously agitated until the material can be drawn free flowing and lump free from the mixing kettle at a temperature within the range recommended by the manufacturer.

Joint sealing compound shall be poured using hand pouring pots, mechanical methods, or any other method that gives satisfactory results.

Shields shall be provided to prevent the compound from being spilled on the concrete curb, barrier or parapet walls, expansion joints, deck drains, and on the newly placed hot mix asphalt.

Sufficient joint sealing compound shall be poured into the groove so that upon completion of the work the surface of the compound is flush with the surface of the pavement. If the compound subsides to a level below the surface of the pavement, a second pouring shall be done. When more than one pouring is required to fill the groove, succeeding pours shall be made immediately.

Damage to the joint sealing compound, such as stones embedded in the compound or that is caused by the Contractor's operation, shall be repaired.

Traffic shall not be permitted over the joint sealing compound until the compound has cooled to ambient temperature.

914.07.08 Samples for Testing

914.07.08.01 Delivery of Samples

Samples of the waterproofing membrane, waterproofing membrane reinforcement, joint sealing compound, tack coat, and the protection board shall be delivered by the Contractor to:

Head, Concrete Section
Ontario Ministry of Transportation
Room 15, Building C
1201 Wilson Avenue
Downsview, Ontario, M3M 1J8

914.07.08.02 Membrane Quality

A 4 litre sample from each lot of waterproofing membrane shall be drawn by the Contractor from the heating and mixing kettle and placed in a container supplied by the Contract Administrator. The samples shall be delivered as specified in the Delivery of Samples clause.

The Contract Administrator shall determine the time of sampling as specified in the Field Guide for the Acceptance of Hot Mix and Bridge Deck Waterproofing.

914.07.09 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

914.08 QUALITY ASSURANCE

914.08.01 Testing of Samples Other than Waterproofing Membrane

The samples of the waterproofing membrane reinforcement, joint sealing compound, tack coat, and protection board delivered by the Contractor to the Owner shall be tested for conformance with the requirements in this specification.

914.08.02 Acceptance of Waterproofing Membrane Thickness

914.08.02.01 General

The Contract Administrator shall determine the acceptability of the waterproofing membrane thickness by determining the waterproofing membrane thickness on a lot-by-lot basis.

914.08.02.02 Testing of Membrane Thickness

The Contract Administrator shall obtain a test result from each sublot. Each test result shall consist of 3 measurements taken at the corners of an imaginary triangle centered about the random location. The sides of the imaginary triangle shall be approximately 0.1 m. The 3 measurements shall be averaged, rounded to the closest 1 mm, and reported as one test result. Measurements shall be made according to the Field Guide for the Acceptance of Hot Mix and Bridge Deck Waterproofing and shall be taken after the Contractor has completed each lot, including the placement of protection board.

914.08.02.03 Membrane Thickness Acceptance Determination

The decision to accept the waterproofing membrane thickness shall be based on the mean and standard deviation of each lot, as specified in this clause.

a) Case 1 - Lot mean is less than 4.0 mm

   If the lot mean is less than 4.0 mm, the entire lot is unacceptable. In such cases the Contractor shall repair the entire lot as outlined below.

b) Case 2 - Lot mean is greater than or equal to 4.0 mm and less than or equal to 6.0 mm

   If the lot mean is greater than or equal to 4.0 mm and less than or equal to 6.0 mm, the mean and the standard deviation shall be rounded to the closest 0.1 mm and 0.05 mm, respectively, and shall then be applied to Table 1 to determine if the lot is in the acceptable, borderline, or unacceptable range.

   If the lot is within the borderline range as shown in Table 1, the Contractor may repair the lot as outlined below or request that the Owner accept the lot as is with a payment adjustment as outlined in the Payment Adjustment Due to Membrane Thickness Deficiency clause.

   If the lot is within the unacceptable range as shown in Table 1, the Contractor shall repair the lot as specified below.

c) Case 3 - Lot mean is greater than 6.0 mm

If the lot mean is greater than 6.0 mm, regardless of the standard deviation, the Contract Administrator shall review the conditions to which the bridge deck shall be exposed and then designate the deck as acceptable or unacceptable. When the lot is designated unacceptable, the Contractor shall repair the lot as outlined below.

914.08.02.04 Repair of Unacceptable or Borderline Lots

When the Contract Administrator identifies an unacceptable lot or the Contractor chooses to improve a borderline lot, the repairs deemed necessary by the Contractor to upgrade the lot shall be made. Any protection boards that are removed during the repairs shall be replaced with new ones. The Contract Administrator shall determine a new set of random locations and shall re-measure and re-evaluate the entire lot for acceptance when notified that the repairs have been completed.

914.08.02.05 Retesting of Waterproofing Membrane Thickness

The Contractor may request retesting if any or all of the 10 sublot test values are challenged. If this occurs, 10 new thickness measurements shall be taken within the lot by the Contract Administrator in the presence of the Contractor. The new test values shall then be used to determine acceptance. Acceptance shall be based on the criteria specified in the Membrane Thickness Acceptance Determination clause and shall be binding on both parties.

914.08.03 Acceptance of Waterproofing Membrane Quality

914.08.03.01 General

The Contract Administrator shall determine the acceptability of the waterproofing by determining the membrane quality on a lot-by-lot basis.

914.08.03.02 Sampling and Testing of Membrane Quality

The sample delivered by the Contractor to the Owner shall be split into two approximately equal parts: one part shall be tested immediately and the other shall be retained for possible retesting. If the tested part fails any of the specification requirements, the retained part shall be kept for 40 Days after the Contractor has been notified of the test results. If the Contractor requests retesting within this time period, the retained part shall be used for this purpose, otherwise it shall be discarded.

914.08.03.03 Membrane Quality Acceptance Determination

The decision to accept the quality of the hot applied waterproofing membrane shall be based on the results of tests performed according to OPSS 1213 and the following criteria.

Membrane quality shall be considered:

a) Acceptable, if all specification requirements for the lot are met; or

b) Borderline and subject to payment adjustment as outlined in the Payment Adjustment Due to Membrane Quality Deficiency clause, if the total number of adjustment points resulting as shown in Table 2 are less than or equal to 25; or

c) Rejectable, if the total number of adjustment points are greater than 25 or if any individual test result falls within the unacceptable range.

914.08.03.04 Retesting for Quality

The Contractor may request, in writing, retesting of any sample, which results in price adjustment or rejection of a lot; however, the request shall be made within 30 Days of receiving notification of price adjustment or rejection of the lot. The results of the retest shall be used for acceptance determination and shall be binding on both parties. If the retest results in either a price adjustment or rejection of the lot, the Contractor shall bear the cost of the retesting. If the retesting results in the material passing all test criteria, a retesting charge shall not be levied against the Contractor.

914.09 MEASUREMENT FOR PAYMENT

914.09.01 Actual Measurement

914.09.01.01 Bridge Deck Waterproofing

Measurement of bridge deck waterproofing shall be by area in square metres. Allowance shall not be made in the measurement for the turn-up at vertical faces, for any overlap, or for a second application of waterproofing membrane over the membrane reinforcement. Alternatively, bridge deck waterproofing may be a lump sum item.

914.09.01.02 Membrane Reinforcement

Measurement of membrane reinforcement shall be by length in metres. Allowance shall not be made in the measurement for the turn-up at vertical faces or for any overlap.

914.09.01.03 Form and Fill Grooves

Measurement of forming and filling grooves shall be by length in metres.

914.09.01.04 Modification of Deck Drains

For measurement purposes, a count shall be made of the number of deck drains modified, regardless of type and size.

914.09.01.05 Deck Surface Preparation

Measurement of deck surface preparation shall be by area in square metres.

914.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

914.10 BASIS OF PAYMENT

914.10.01 Bridge Deck Waterproofing - Item
Membrane Reinforcement - Item
Form and Fill Grooves - Item
Deck Surface Preparation - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

When the Contract does not contain separate tender items for the work required by this specification, payment at the Contract price for the tender item Bridge Deck Waterproofing shall be full compensation for all labour, Equipment, and Material to do the work.

When repairs or remedial work to the concrete deck is required prior to abrasive blast cleaning and the work is not specified in the Contract Documents, payment for the cost of such work shall be administered as Extra Work.

Repairs to damaged grooves shall be made at the Contractor's expense at no additional cost to the Owner.

914.10.01.01 Payment Adjustment Due to Membrane Thickness Deficiency

When a lot is within the acceptable range as shown in Table 1, a payment adjustment factor of 1.00 shall be applied to the Contract price for the lot.

When a lot is within the borderline range as shown in Table 1 and the Contractor requests that the Owner accept the lot as is, the Contract price for the item Bridge Deck Waterproofing shall be multiplied by the payment adjustment factor specified in Table 1 to determine the adjusted Contract price for the lot.

914.10.01.02 Payment Adjustment Due to Membrane Quality Deficiency

Quality Payment Adjustment Factors are calculated as follows:

a) If the sample meets all test criteria as shown in Table 2, the Contract Administrator shall assign a quality adjustment factor of 1.00.

b) If the sample fails one or more test criteria, the adjustment points as shown in Table 2 for each failed criteria shall be totalled. The Contract Administrator shall assign a quality adjustment factor which shall be 100 minus the total of all the adjustment points and the results divided by 100.

c) If the sample fails one or more test criteria, the adjustment points as shown in Table 2 for each failed criteria shall be totalled and if the total number of points exceed 25, the Owner shall not pay the Contractor for the lot regardless of the adjustment factor for thickness.

d) If an individual test result is inside the rejection value range, the Owner shall not pay the Contractor for the lot, regardless of the adjustment factor for thickness.

914.10.01.03 Calculation for Total Adjustment Payment

The total adjusted payment for the lot shall be based on the thickness and on the quality for the waterproofing membrane and is calculated as follows:

The Contract price for the lot shall be multiplied by the thickness adjustment factor and the results shall then be multiplied by the quality adjustment factor.

914.10.02 Modification of Deck Drains - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

TABLE 1
Acceptance Determination and Payment Adjustment Factors Membrane Thickness

Lot Standard Deviation		Lot Mean														Lot Standard Deviation
		4.0	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9	5.0	5.1	5.2		
	0.0														0.0	
	.05														.05	
	.10														.10	
	.15														.15	
	.20														.20	
	.25														.25	
	.30														.30	
	.35														.35	
	.40														.40	
	.45	Acc													.45	
	.50	.99	Acc												.50	
	.55	.94	.99	Acc											.55	
	.60	.83	.95	.99	Acc										.60	
	.65	Una	.86	.95	.99	Acc									.65	
	.70	Una	.59	.87	.96	.99	Acc								.70	
	.75		Una	.71	.89	.96	.99	Acc							.75	
	.80			Una	.76	.91	.96	.99	Acc						.80	
	.85				Una	.81	.91	.96	.99	Acc					.85	
	.90					Una	.83	.92	.97	.99	.99	Acc			.90	
	.95					Una	.64	.84	.93	.97	.99	.99	Acc		.95	
	1.00						Una	.71	.87	.93	.97	.99	.99	Acc	1.00	

Table 1 continued on next page.

TABLE 1 (Cont'd)
Acceptance Determination and Payment Adjustment Factors Membrane Thickness

Lot Standard Deviation	Lot Mean																Lot Standard Deviation
	4.6	4.7	4.8	4.9	5.0	5.1	5.2	5.3	5.4	5.5	5.6	5.7	5.8	5.9	6.0		
1.05	Una	.76	.87	.94	.97	.99	.99	Acc								1.05	
1.10		Una	.79	.89	.94	.97	.99	.99	Acc							1.10	
1.15		Una	.59	.81	.90	.95	.97	.99	.99	Acc						1.15	
1.20			Una	.64	.83	.91	.95	.97	.99	.99	Acc					1.20	
1.25				Una	.71	.84	.91	.95	.97	.99	.99	Acc				1.25	
1.30					Una	.76	.86	.92	.95	.97	.99	.99	Acc			1.30	
1.35						Una	.77	.87	.92	.95	.98	.99	.99	Acc		1.35	
1.40						Una	.59	.79	.87	.93	.96	.98	.99	.99	Acc	1.40	
1.45							Una	.68	.82	.88	.93	.96	.98	.99	.99	1.45	
1.50								Una	.71	.83	.89	.93	.96	.98	.99	1.50	
1.55									Una	.74	.84	.90	.94	.96	.98	1.55	
1.60										Una	.78	.86.	91.	.94	.96	1.60	
1.65										Una	.64	.79	.87	.91	.94	1.65	
1.70											Una	.88	.81	.87	.91	1.70	
1.75												Una	.71	.82	.87	1.75	
1.80													Una	.74	.83	1.80	
1.85													Una	.59	.76	1.85	
1.90														Una	.64	1.90	
1.95															Una	1.95	
2.00															Una	2.00	

Notes:

A. Cells containing the Payment Adjustment Factors form the borderline range.

B. "Acc" means acceptable. All cells above cells containing Payment Adjustment Factors form the acceptable range.

C. "Una" means unacceptable. All cells below cells containing Payment Adjustment Factors form the unacceptable range.

TABLE 2
Acceptance Determination and Payment Adjustment Factors Membrane Quality

Test	Specification Limits	Adjustment Points	Rejection Value
Cone Penetration at 25 °C	Max. 110	0.4 per 1	> 130
Cone Penetration at 50 °C	Max. 160	0.4 per 1	> 180
Flow at 60 °C	Max. 3 mm	0.5 per 1	> 5
Low Temperature Flexibility at -25 °C	Pass	5.0 for Failure	--
Toughness	Min. 5.5	0.5 per 0.1	< 4.0
Toughness/Peak Load	Min. 0.040	0.5 per 0.001	< 0.030

Appendix 914-A, November 2014
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Location of any 20 mm wide and 20 mm deep rectangular groove required in the asphaltic concrete. (914.07.07)

OPSS 914 contains information that is not used by municipalities in their Contracts. To ensure completeness of the municipal Contract Documents, the designer should invoke Appendix 914-B. The appendix contains information that modifies OPSS 914 so it can be used by a municipality in its Contracts.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

Appendix 914-B, November 2014
FOR USE IN MUNICIPAL CONTRACTS, WHEN REFERENCED IN THE CONTRACT DOCUMENTS

Note: This is a non-mandatory Additional Information Appendix intended to provide supplementary requirements for the OPS specification in a municipal contract, when the appendix is invoked by the Owner. It is written in mandatory language to permit invoking it by reference in the Contract Documents. If the appendix has not been invoked by reference in the Contract Documents, it does not apply.

Supplemental Requirements for Using OPSS 914 in Municipal Contracts

OPSS 914, Waterproofing Bridge Decks with Hot Applied Asphalt Membrane, is amended as follows:

914.07.08.01 Delivery of Samples

Clause 914.07.08.01 is deleted in its entirety and replaced by the following:

Samples of the waterproofing membrane, waterproofing membrane reinforcement, joint sealing compound, tack coat, and the protection board shall be delivered to the Contract Administrator.

CONSTRUCTION SPECIFICATION FOR SIGN SUPPORT STRUCTURES

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915.10 **BASIS OF PAYMENT**

APPENDICES

915-A **Commentary**
915-B **Supplemental Requirements for Use in Municipal Contracts**

915.01 SCOPE

This specification covers the requirements for the design and construction of the tri-chord, cantilever, variable message, monotube overhead, bridge mounted, and roadside breakaway and non-breakaway sign support structures, including their footings.

915.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

915.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

915.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 501	Compacting
OPSS 603	Installation of Ducts
OPSS 609	Grounding
OPSS 902	Excavating and Backfilling - Structures
OPSS 903	Deep Foundations
OPSS 904	Concrete Structures
OPSS 905	Steel Reinforcement for Concrete
OPSS 906	Structural Steel for Bridges
OPSS 907	Structural Wood Systems
OPSS 911	Coating Structural Steel Systems
OPSS 919	Formwork and Falsework

Ontario Provincial Standard Specifications, Material

OPSS 1010	Aggregates - Base, Subbase, Select Subgrade, and Backfill Material
OPSS 1350	Concrete - Materials and Production
OPSS 1440	Steel Reinforcement for Concrete
OPSS 1601	Wood - Preservative Treatment and Shop Fabrication

Ontario Ministry of Transportation Publications

Sign Support Manual

Structural Manual

CSA Standards

G40.20-04/G40.21-04 (R2009)	General Requirements for Rolled or Welded Structural Quality Steel / Structural Quality Steel
S6-06	Canadian Highway Bridge Design Code
S157-05/S157.1-05 (R2010)	Strength Design in Aluminum / Commentary on CSA S157-05, Strength Design in Aluminum
W47.2-11	Certification of Companies for Fusion Welding of Aluminum
W59-03 (R2008)	Welded Steel Construction (Metal Arc Welding)
W59.2-M1991 (R2008)	Welded Aluminum Construction
W178.1-08	Certification of Welding Inspection Organizations
W178.2-08	Certification of Welding Inspectors

American Association of State Highway and Transportation Officials (AASHTO)

LTS-5-M	Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, 5th Edition, with 2010 Interim Revisions

ASTM International

A 307-10	Carbon Steel Bolts and Studs 60,000 PSI Tensile Strength
A 325-10	Structural Bolts, Steel, Heat Treated 120/105 ksi Minimum Tensile Strength
A 325M-09	Structural Bolts, Steel Heat Treated 830 MPa Minimum Tensile Strength, Metric
A 500-10a/A500M-10a	Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
B 209M-07	Aluminum and Aluminum Alloy Sheet and Plate, Metric
B 221M-07	Aluminum and Aluminum Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
F 593-02 (2008)e1	Stainless Steel Bolts, Hex Cap Screws, and Studs

Canadian General Standards Board (CGSB)

48.9712-2006	Non-Destructive Testing-Qualification and Certification of Personnel

International Organization for Standardization/International Electrotechnical Commission (ISO/IEC)

17025-2005, 2nd Ed.	General Requirements for the Competence of the Testing and Calibration Laboratories

915.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Cantilever Sign Support Structure means an overhead sign support structure consisting of horizontal members mounted to one side, both sides, or centre mounted, to a single vertical leg.

Certificate of Conformance means a document issued by the Quality Verification Engineer confirming that the specified components of the Work are in general conformance with the requirements of the Contract Documents.

Column means the vertical member of a roadside sign support structure that has the base section of the member buried below grade and the upper section connected to a sign or sign support.

Crank Location means the joint in the end panel of a variable message sign support structure where the horizontal chords meet the sloping chords.

Engineer means a professional engineer licensed by the Professional Engineers Ontario to practice in the Province of Ontario.

Leg means the vertical member of an overhead sign support structure that connects to the sign support footing.

Overhead Monotube Sign Support Structure means an overhead sign support structure consisting of two vertical single steel tubing legs spanned by a single steel tubing member.

Overhead Sign Support Structure means a structure for supporting signs over a roadway.

Proposal means a Contractor's submission for which engineering design is required that provides a written:

a) Alternative to requirements specified by the Owner in the Contract Documents.

b) Course of action or undertaking by the Contractor, as delegated by the Owner in the Contract Documents.

Quality Verification Engineer (QVE) means an Engineer retained by the Contractor qualified to provide the services as specified in the Contract Documents.

Roadside Sign Support Structure means a timber or steel, breakaway or non-breakaway, sign support structure, consisting of two or more columns on the side of the roadway.

Sign means a variable message board or a signboard.

Sign Support Structure means an overhead sign support structure or a roadside sign support structure.

Sweep means the deviation from straightness of a member or any portion of a member with respect to its minor axis.

Tri-Chord Sign Support Structure means a static sign support structure consisting of a galvanized steel overhead truss constructed in the form of a three-chord system and having tubular legs.

Variable Message Sign Support Structure means an overhead sign support structure with two steel legs, consisting of a pair of trussed members, and an aluminum truss spanning the roadway.

915.04 DESIGN AND SUBMISSION REQUIREMENTS

915.04.01 Design Requirements

Sign support structure design shall be according to CAN/CSA S6, AASHTO LTS-5-M, the Sign Support Manual, the Structural Manual, and the requirements of this specification.

The catwalk grating shall be designed for a live load of 5 kPa.

Welding design shall be according to CSA W59.2M for aluminum and CSA W59 for steel.

915.04.02 Submission Requirements

915.04.02.01 General

Working Drawings and erection procedures shall be according to the Contract Documents. An Engineer's seal and signature shall be affixed on the Working Drawings and erection procedures verifying that they are consistent with the requirements of the Contract Documents.

All submissions shall be according to the appropriate clause.

When other authorities are involved in the approval of the design or construction of a highway structure, the submission shall be made at least 5 weeks prior to commencement of work and one additional copy of the required submission shall be provided for each other authority.

915.04.02.02 Working Drawings for Sign Support Structures

The Contractor shall submit 3 sets of Working Drawings to the Contract Administrator at least 7 Days prior to commencement of fabrication of overhead sign support structures, for information purposes only.

The fabricator shall have a sealed and signed copy of the Working Drawings at the manufacturing facility during fabrication. Working Drawings shall include at least the following information:

a) Fabrication details.

b) Specifications of the material to be used.

c) Design, assembly, and detail drawings including welding procedures according to CSA W59.2-M for aluminum and CSA W59 for steel.

d) Fastener torquing values and methods.

e) For variable message sign support structures, structural details of the sign, including the catwalk, aluminum skin, and attachment to the sign support structure.

f) Coating requirements.

915.04.02.03 Delivery Schedule for Overhead Sign Support Structures

The delivery schedule of overhead sign support structures and their components to the galvanizing or painting facility or both, and to the site, shall be provided to the Contract Administrator not less than 7 Days before shipping begins.

915.04.02.04 Rock Excavation

If rock is present within the depth of the footing as specified in the Contract Documents, the Contractor shall submit the proposed method of rock excavation to the Contract Administrator at least 14 Days prior to the commencement of excavation, for information purposes only.

915.04.02.05 Erection Procedures for Overhead Sign Support Structures

The Contractor shall submit 3 copies of the erection procedures to the Contract Administrator at least 7 Days prior to the commencement of overhead sign support structure erection, for information purposes only.

The Contractor shall have a copy of the erection procedures at the site during erection. The erection procedures shall include at least the following:

a) Proposed method and sequence of erection.

b) Weight and lifting points of the members.

c) Locations and lifting capacities of the cranes to be used to lift the members.

d) Details of temporary bracing and temporary supports used during construction, including time and sequence of removal.

e) Calculations.

f) Fastener torquing values and methods.

g) Method of maintaining the columns and anchorages vertical and in the specified location in the footings until the concrete has set.

h) Erection tolerance between the end diagonal and the corbel for the tri-chord sign support structure truss.

915.04.02.06 Proposals

The Contractor shall submit 5 copies of any proposal by the Contractor to the Contract Administrator at least 14 Days prior to commencement of the work for review. Proposals shall bear the seals and signatures of a design Engineer and a design-checking Engineer. The Contractor shall not proceed with the changes until the Contract Administrator has accepted the proposal.

915.04.02.07 Mill Test Certificates

Prior to the use of any material in fabrication, 2 copies of the mill test certificates for that material shall be submitted to the Contract Administrator confirming that the material is according to the Contract Documents.

Verification that bolts, nuts, and washers meet the chemical composition, mechanical properties, dimensions, workmanship, and head burst as required by the appropriate ASTM specification specified in the Contract Documents shall also be submitted to the Contract Administrator.

Copies of the mill test certificates for all material to be used in the fabrication shall be available for review at the fabricating plant during fabrication. The certificates shall show that the material is according to the Contract Documents.

If the material cannot be identified by mill test certificates, coupons shall be taken and tested and these test certificates shall be made available.

When mill test certificates originate from a mill outside Canada or the United States of America, the Contractor shall have the information on the mill test certificate verified by testing by a Canadian laboratory. This laboratory shall be certified by an organization accredited by the Standards Council of Canada to comply with the requirements of ISO/IEC 17025 for the specific tests or type of tests required by the material standard specified on the mill test certificate. The mill test certificates shall be stamped with the name of the Canadian laboratory and appropriate wording stating that the material is in conformance with the requirements as specified in the Contract Documents. The stamp shall include the appropriate material specification number, testing date (i.e., yyyy-mm-dd), and the signature of an authorized officer of the Canadian laboratory.

915.04.02.08 Inspection Company and Inspector Information

The Contractor shall submit the names of the inspection company and the inspectors, together with proof of certification, to the Contract Administrator a minimum of 7 Days prior to commencement of fabrication of overhead sign support structures, for information purposes only.

915.05 MATERIALS

915.05.01 General

Material not specified in the Contract Documents shall be appropriate for its end use and shall be compatible with the sign structure metal.

915.05.02 Aluminum

Extruded aluminum tubing shall be 6061-T6 alloy according to ASTM B 221M.

Aluminum sheet and plate shall be 6061-T6 alloy according to ASTM B 209M.

Dissimilar metal shall not come in contact with aluminum.

915.05.03 Fasteners

Stainless steel fasteners shall be according to ASTM F 593, Alloy 304 or 316.

Lock nuts shall be nylon insert type.

Galvanized steel fasteners shall be according to ASTM A 307, ASTM A 325, or ASTM A 325M as specified in the Contract Documents and the requirements of the High Strength Bolts, Nuts, and Washers subsection of OPSS 906.

915.05.04 Clamps

Clamps shall be as specified in the Contract Documents.

915.05.05 Steel

Steel shall be according to CSA G40.21, ASTM A 500, OPSS 906, and as specified in the Contract Documents.

915.05.06 Concrete

Concrete shall have a nominal minimum 28-Day compressive strength as specified in the Contract Documents, and shall be according to OPSS 1350.

A superplasticizer shall be used to attain a slump of 150 mm $\pm$ 30 mm.

915.05.07 Reinforcing Steel

Reinforcing steel shall be a minimum Grade 400W steel and shall be according to OPSS 1440.

915.05.08 Wood

Wood shall be Grade No. 1 Coast Douglas Fir, or Grade No. 1 Jack Pine - Beam and Stringer Grade, or Post and Timber Grade categories as specified in the Contract Documents, and shall be according to OPSS 1601.

Wood shall be pressure preservative treated according to OPSS 1601.

915.05.09 Anchorage Assembly

Bolts, studs, struts, and coils shall be as specified in the Contract Documents. The anchorage assembly shall be hot dip galvanized according to the Contract Documents. The anchorage assembly shall be supplied with the fasteners installed in a rigid template.

915.05.10 Primer and Locking Compound

The thread-locking compound shall be a removable medium strength, single component anaerobic thread locking material that allows disassembly with hand tools. The primer shall be as recommended by the manufacturer of the locking compound.

915.05.11 Electrical

Ducts and fittings for electrical work shall be as specified in the Contract Documents and according to OPSS 603.

Electrical grounding posts at handholes shall be according to OPSS 609.

915.05.12 Granular Backfill

Granular backfill shall be as specified in the Contract Documents and according to OPSS 1010.

915.05.13 Coatings

Paint and metallic coatings shall be as specified in the Contract Documents and according to OPSS 911.

915.07 CONSTRUCTION

915.07.01 Fabrication

915.07.01.01 Aluminum Sign Support Structures

915.07.01.01.01 General

The aluminum fabrication shall be according to CSA W59.2M.

Cutting shall be done by shearing, sawing, milling, or plasma arc. Flame cutting of components is not permitted. In straightening out parts, only plastic or rubber hammers shall be used. All sharp edges and burrs shall be removed. Components cracked or ruptured at any time shall be replaced.

915.07.01.01.02 Welding

The company performing the welding shall be certified according to CSA W47.2, Division 1 or Division 2.1. Qualification for welding and workmanship shall be according to the requirements of CSA W59.2M.

Welding jigs and fixtures shall be used to hold the connector assemblies in position during fabrication.

All areas to be welded shall be free of grease and cleaned with grease free aluminum or stainless steel brushes. All Welds shall be made using MIG process according to CSA S157, Section 26.12. All welds shall be cleaned of soot.

Components to be joined by fillet welding shall have a separation no greater than 1.5 mm.

Unless noted on the Working Drawings or otherwise approved in writing by the Contract Administrator, field welding shall not be permitted. When field welding is permitted, it shall be done by a welder certified for all position welding according to CSA W47.2.

915.07.01.01.03 Bridge Mounted Sign Support Structures

When the location of attachment on a structure is not specified in Contract Documents, the attachment to the structure shall be located to minimize the fatigue affects on the support structure as determined by the Contract Administrator.

For anchors, the Contractor shall prepare, clean, and place adhesive in the drill holes as per the manufacturer's recommendations. Prior to drilling holes, the Contractor shall locate existing steel reinforcement, Utility ducts, post tensioning hardware, and any unsound concrete in the vicinity of the dowel locations. The Contractor's installation operations shall not damage the steel reinforcement, the surrounding concrete, or any other embedments.

915.07.01.02 Steel Sign Support Structures

915.07.01.02.01 General

The steel fabrication shall be according to the Working Drawings and OPSS 906, except as specified in this specification.

Circular structural tubing shall have no more than one longitudinal weld. Octagonal legs shall have no more than two longitudinal welds. Longitudinal welds in legs shall be full penetration and done using an automatic welding process. Longitudinal welds in legs shall be in a plane through the centroid of the section that is parallel to the signboard.

If an octagonal cross section is used for the legs, it shall be produced by mechanically bending the material. The centroid of the octagonal section shall be coincident with the specified circular shape.

915.07.01.02.02 Welding

Welding shall be according to CSA W59. All accessible welds, except fillet welds, shall be ground smooth.

915.07.01.02.03 Steel Monotube Overhead Sign Support Structures

The members shall be octagonal in cross-section and when tapered, the taper shall be uniform. Legs shall have one or two longitudinal automated electrically welded joints along their full length.

Circumferential welds shall be full penetration welds and shall be ground flush on the exterior face. The maximum permitted number of circumferential welded joints in a member length, as measured between the connections shall be as follows:

a) Up to and including 9 m - one weld.

b) Greater than 9 m - two welds.

Circumferential welds shall not be located less than 2.7 m from a bolted connection and all welding shall be carried out prior to galvanizing.

Sweep, in millimetres, shall not exceed:

(Total Length of Member in Metres / 15) x 10.4 mm

All welding at flange plates shall develop the full strength of the adjacent shaft section.

The column base plates shall be flush with the bottom of the columns. The base plates shall be positioned perpendicular to the centreline of the columns. The flange plates shall be positioned to provide the specified camber of the horizontal member after erection. After fabrication, the faces of the base plates and flange plates shall be true and free from distortion.

A waterproof removable galvanized steel top cap shall be furnished with each leg. The caps shall blend with the general column design to present a neat overall appearance. Each cap shall be rigidly secured to the column by a hexagonal head stainless steel set screw. The flange plates, handholes, access nipples for wiring, grounding lugs, and mounting brackets shall be accurately positioned on the members. The wiring apertures shall provide a smooth cable entrance into the members.

915.07.01.02.04 Coating

All steel components of steel sign support structures shall be hot dip galvanized according to OPSS 911.

The galvanized surface to receive a subsequent paint coating shall be specified in the Contract Documents. Coating of the components shall be according to OPSS 911.

915.07.01.03 Mechanical Access for Electrical Work

Legs adjacent to the power source shall be fabricated with handhole frames complete with covers and gaskets. The strength of the leg at the section through the handhole shall not be less than the original section. When specified in the Contract Documents, grounding lugs, fuse clips, and access nipples for wiring shall be installed during shop fabrication.

915.07.01.04 Identification of Overhead Sign Support Structures

Each sign support structure shall have a site identification marking located approximately 1 m above the footing showing the following information:

a) Site identification number.

b) Manufacturer's name or trademark.

c) Date of manufacture.

d) Maximum sign area.

e) Design wind pressure.

The marking shall be on a corrosion resistant plate securely attached by means of stainless steel band clamps. The plate shall be attached on the right leg viewed in the direction of traffic. The maximum size of plate shall be 150 x 150 mm.

The site identification number, maximum sign area, and design wind pressure for each sign support structure shall be as specified in the Contract Documents.

915.07.01.05 Shipment of Sign Support Structures and Their Components

Each sign support structure shall be shipped, complete with hardware, suitably packaged to ensure that all components are delivered together with tags attached noting the site identification number. The fuse connector clip and grounding post shall be assembled inside the leg before shipment.

915.07.01.05.01 Transporting, Unloading, Storing, and Handling Components

The components shall only be handled at the lifting points shown in the Working Drawings using non-metallic lifting slings.

The components that are to receive a paint coating after galvanizing shall be identified when delivered to the galvanizing plant.

The Contractor shall perform all work necessary to ensure safe loading, delivery, unloading, and storage of components at the specified site. Components shall be loaded for shipping in a manner that they can be transported and unloaded at its destination without being overstressed or damaged. When stored, components shall be stockpiled to avoid permanent deformation or damage.

Advertising by means of removable signing is permitted on elements only while in transit to the specified site. Painting of advertisements directly on elements is not permitted.

915.07.01.05.02 Storage of Signboard Chord Clamps

When the Contract Documents do not include the installation of the signboard for each overhead sign structure, the chord clamps required for fastening the sign shall be placed in burlap bags with tags marked with the size of clamps and the identification number of the sign structure on which they are to be used. Chord clamps prepared in this manner shall be delivered to the Owner for storage as specified in the Contract Documents.

915.07.02 Footings for Overhead Sign Support Structures

915.07.02.01 General

The footings shall be constructed plumb to within 1H:100V.

The tolerance for the location of the centre of the constructed footing shall be 75 mm from the location as specified in the Contract Documents.

915.07.02.02 Excavation

The excavation shall be to the lines and grades as specified in the Contract Documents and according to OPSS 902.

Cylindrical shaft footings for overhead sign support structures shall be constructed as caisson piles according to OPSS 903.

When soil with unexpected very low bearing capacity or unexpected rock is encountered at a depth less than the full depth of the footing, the excavation shall be stopped and the Contract Administrator shall be notified immediately.

915.07.02.03 Formwork

Formwork shall be according to OPSS 919.

The footing shall be formed to a minimum of 150 mm below finish grade. Formwork shall be removed to a minimum depth of 150 mm below finished grade prior to placing granular backfill.

915.07.02.04 Reinforcing Steel

Reinforcing steel shall be placed according to OPSS 905.

915.07.02.05 Anchorage Assembly

The anchorage assembly shall be installed level to the tolerances as specified in the Contract Documents. The tolerance for the location of the centre of the anchorage assembly shall be 50 mm from the centre of the footing. Anchorage assemblies shall be securely tied to the reinforcing steel and provided with supports to maintain its position during the placing of concrete. The anchorage assembly shall not be welded to the reinforcing cage and shall remain plumb to within 1H:200V. The anchorage assembly setting templates shall remain in place until after the curing period of the concrete.

The tolerance for the centre to centre of the anchorage assemblies for the following structure types shall be according to the following:

Tri-chord sign support structure:	- 25 mm to + 50 mm
Variable message sign support structure:	± 25 mm
Monotube overhead sign support structure:	± 25 mm

A primer and locking compound shall be applied to the anchor bolts during erection of the overhead sign structure.

Bedding grout shall not be used under the base plates for tri-chord, cantilever, or monotube overhead sign support structures.

915.07.02.06 Electrical Ducts and Fittings

All work for electrical ducts and fittings shall be according to OPSS 603.

When rigid duct sleeves in footings are specified in the Contract Documents, they shall be located to suit incoming duct or cable systems and shall be securely tied to steel reinforcement, prior to placing concrete.

All rigid duct sleeves shall be cut off cleanly above the footing ensuring a minimum projection of 150 m above the base plates. Rigid duct sleeves shall be temporarily plugged or sealed until the ducts or cable systems are installed.

915.07.02.07 Concrete

Concrete work shall be according to OPSS 904.

Concrete shall be placed against undisturbed soil and the top of the footing shall be float finished level to a tolerance of ± 0.1 degree in any direction and within ± 10 mm of the elevation as specified in the Contract Documents. The top surfaces shall be finished free of depressions. The concrete surface in contact with the base plate shall be steel float finished.

Concrete shall be cured according to the following:

a) Curing of the formed sign support footings shall be a minimum of 96 hours.

b) Wet burlap shall be applied to the top unformed surface of the footing immediately after completion of the finishing operation without damaging or marring the surface of the concrete and maintained in a wet condition for the minimum curing period.

c) When the formwork is left in place for 96 hours or more, no additional curing of the formed concrete surface is required.

d) When the formwork is removed in less than 96 hours, the formed concrete surface shall be cured with burlap and water for the remainder of the minimum curing period.

e) When white-pigmented membrane is used as a curing compound on an adjacent concrete barrier, a minimum of one coat of the curing compound shall be applied to the concrete footing immediately after completion of the curing cycle for the footing for colour uniformity. Additional curing compound shall be applied, as necessary, to ensure colour uniformity.

f) The curing compound shall only be used on the exposed surfaces of the footings. No curing compound shall be applied onto construction joints.

Prior to the erection of the sign support structure, curing of the footing shall be complete and the concrete shall be at a minimum compressive strength of 25 MPa.

915.07.03 Erection of Overhead Sign Support Structures

915.07.03.01 General

The Contract Administrator shall be notified in writing a minimum of one week prior to the commencement of field operations and erection work.

Components shall be erected using appropriate lifting equipment, temporary bracing, guys, and stiffening devices so that the components are at no time overstressed, unstable, unsafe, or damaged.

The fully assembled truss of the variable message sign support structure shall be erected in one lift.

Legs of structures with rigid corners shall not be forced into position on to the anchorage bolts.

915.07.03.02 Legs

Legs of structures shall be erected plumb to within a tolerance of 1H:200V.

915.07.03.03 Field Cutting

Field cutting of material is not permitted.

915.07.03.04 Attachments to Sign Support Structures

Attachments to the sign support structure shall only be made with clamps. Welding shall not be used for any attachment to the sign support structure.

915.07.03.05 Field Splices

Bolted field splices specified in the Contract Documents shall have full contact bearing when assembled and shall not have a separation exceeding 0.5 mm for at least 75% of the entire contact area. The separation of any remaining portion shall not exceed 1 mm.

915.07.03.06 Fastener Torquing

Fasteners shall be torqued as specified in the Contract Documents.

915.07.04 Breakaway and Non-Breakaway Roadside Sign Support Structures

915.07.04.01 General

The excavation for the footings of the steel columns and the installation of the wood columns shall be augered in undisturbed soil to the dimensions and at the locations as specified in the Contract Documents. The elevation of the bottom of the excavation shall be as specified in the Contract Documents or as determined by the Contract Administrator. Sidewall stability shall be maintained throughout the excavation, concrete placement for steel columns, and installation of the wood columns. The formation of cavities in the wall and the flow of soil or water into the excavation shall be prevented. All loose material shall be removed from the bottom of the excavation and the excavation shall be inspected and accepted by the Contract Administrator prior to continuing the work.

When soil with unexpected very low bearing capacity or unexpected rock is encountered at a depth less than the full depth of the footing, the excavation shall be stopped and the Contract Administrator shall be notified immediately.

Centreline of the columns and column stubs shall be within 50 mm of the centreline of the as-built footing.

Centre to centre spacing of columns, column stubs, or column assemblies shall be $\pm$ 50 mm.

Height of signboard attachment holes shall be $\pm$ 10 mm.

915.07.04.02 Steel Roadside Sign Support Structures

915.07.04.02.01 Footings

Concrete for the footing shall be placed against undisturbed soil. The top of the footing shall be shaped to a dome with the top of the dome a minimum of 25 mm above the surrounding ground. The concrete shall be cured with curing compound, except in cold weather. In cold weather concrete shall be placed and protected according to OPSS 904.

Minimum edge distance of the column components from the edge of concrete footing shall be 75 mm.

915.07.04.02.02 Column Erection

The columns shall be maintained vertical to within a tolerance of 1H:200V and oriented within the tolerances as specified in the Contract Documents until the concrete has set.

For the transverse alignment of the columns, the column components shall be installed so that the faces in contact with the cross-arms shall line up and be coplanar. The cross-arms and sign panels shall not be distorted.

The assembled elements constituting the column shall be straight and concentric with a maximum offset from the vertical axis of 5 mm at any joint.

Shims shall not be used in the assembly of the columns and joints, except at the column stub to lower column connection.

915.07.04.02.03 Breakaway Type Columns

The top surface of the friction plate on the column stub shall be installed level at the elevation as specified in the Contract Documents and maintained in this position during the placing and setting of the concrete. The contact areas of the friction plate, fuse plate, and column flange shall be smooth; clean; and free of galvanized beads, runs, and other imperfections that may impair the sliding action.

915.07.04.03 Wood Roadside Sign Support Structures

915.07.04.03.01 Footings

The columns shall be maintained vertical to within a tolerance of 1H:200V and within the tolerances as specified in the Contract Documents until the backfill has been completed.

Granular backfill shall be compacted according to OPSS 501. The top layer shall extend 100 mm above the surrounding ground and shall be sloped away from the column to provide water run off.

The backfill operation shall be completed prior to the attachment of the signs.

915.07.04.03.02 Field Installation

Field erection and cut surface treatment shall be according to OPSS 907.

The pressed steel shear plates shall be installed in grooves according to manufacturer's recommendations.

The splice surfaces shall be flat and perpendicular to the centreline of the post to ensure full plate contact and shall be used as templates for drilling the holes.

915.07.05 Site Trimming Around Footings

The area surrounding the footing shall be trimmed and finished as specified in the Contract Documents.

915.07.06 Attachment of Signboards

The signboards shall be installed at locations as specified in the Contract Documents using fasteners appropriate for the application.

915.07.07 Quality Control

915.07.07.01 General

The quality control of all fabrication processes shall be according to OPSS 906, except as modified in this specification.

An inspector performing the visual inspection shall be certified according to CSA W178.2. Certification shall be to either Level II or III for the methods used.

A testing company shall be employed by the Contractor to do the non-destructive testing of welds and shall be an independent testing organization that is certified by the Canadian Welding Bureau to the requirements of CSA W178.1 for testing of industrial structures by radiographic, ultrasonic, magnetic particle, and liquid penetrant test methods.

Testing shall be done by a non-destructive testing technician certified by the Canadian Welding Bureau according to CAN/CGSB 48.9712. Certification shall be either Level II or III for the methods used.

The technician and the testing company shall not be changed without the prior approval of the Contract Administrator.

Visual inspection and non-destructive testing of steel components shall be according to CSA W59 and as specified in this specification. The acceptance standards of CSA W59 for dynamically loaded structures shall apply.

Visual inspection and non-destructive testing of aluminum components shall be according to CSA W59.2M and as specified in this specification. The acceptance standards of CSA W59.2M for dynamically loaded structures shall apply.

915.07.07.02 Fabrication, Inspection, and Testing

The materials used shall be identified in the fabricator's plant and shall be certified to be according to the requirements in the Material section.

The work shall be inspected and tested to confirm the acceptability of the fabrication, as follows:

a) On completion of fabrication, all welds shall be visually inspected.

b) The following connections shall be tested by magnetic particle testing for steel:

   i. Column to base plate, stiffeners to column, and stiffeners to base plate for the cantilever, tri-chord, variable message and monotube overhead sign support structures.
   ii. Cantilever sign support arm to leg connection plates, stiffeners to arm connection plate, and stiffeners to leg connection plate.

c) All longitudinal groove welds shall be tested prior to assembly of any component to the legs using ultrasonic testing methods. The length and location of welds to be tested shall be as follows:

   i. The first 2 m of the leg measured from the base plate of tri-chord and monotube overhead sign support structures.
   ii. The full length of the legs of the cantilever sign support structures.

d) All circumferential welds shall be tested using ultrasonic testing methods.

e) All full penetration groove welds at the 8-chord crank locations of the aluminum end panels of the variable message sign support structures shall be tested using ultrasonic testing methods.

A written inspection report of the observations and tests shall be issued to the Contractor.

915.07.07.03 Field Inspection

915.07.07.03.01 Erected Sign Structure Inspection

An inspector shall be provided and in attendance to observe the erection operation and to report on compatibility of anchor layout and holes in the base plate and the general alignment, fit up, and bolting, including confirmation that the tolerance as specified in the Contract Documents between the first diagonal and the corbel is maintained in the tri-chord sign support structure.

The inspector shall visually inspect all components for dents, cracks, ruptures, and loose or improperly fitted clamps and fasteners, including tensioning of fasteners, as well as the presence of all drain and vent holes as specified in the Contract Documents.

A written inspection report of the observations shall be issued to the Contractor.

915.07.07.03.02 Concrete Inspection

The concrete shall be according to the submitted mix design and meet the specification requirements for air content, slump, temperature, concrete strength, and delivery time.

Testing of concrete for air content, slump, and temperature; concrete strength; and casting of cylinders shall be carried out according to OPSS 904.

When early strength of the concrete is to be established, additional cylinders shall be cast.

A written inspection report of the observations and tests shall be issued to the Contractor.

915.07.07.04 Coating Inspection

Coating inspection shall be according to OPSS 911.

A written inspection report of the observations and tests shall be issued to the Contractor.

915.07.07.05 Inspection Reports

The Contractor shall submit 4 copies of all inspection reports to the Contract Administrator within 7 Days after inspection.

Inspection reports shall bear the seal and signature of an Engineer.

915.07.08 Interim Inspections

915.07.08.01 Interim Inspection After Construction of Footings

Upon completion of the construction of the footings, and prior to erection of overhead sign support structures, an Engineer shall conduct an interim inspection of the work to verify that the footings have been constructed in general conformance with the Working Drawings and as specified in the Contract Documents, including requirements for the location, top of footing elevation, anchorage layout, and surface finished to the specified tolerances, and issue the Contractor written permission to proceed with the work.

915.07.08.02 Interim Inspection After Fabrication of Components

Upon completion of fabrication of overhead sign support structure components, and prior to erection, an Engineer shall conduct an interim inspection of the work to verify that the fabrication of the sign support structure components has been carried out in general conformance with the Working Drawings and as specified in the Contract Documents, and issue the Contractor written permission to proceed with the work.

915.07.09 Repair of Sign Support Structures

915.07.09.01 General

This shall only apply to rehabilitation and refurbishment of existing sign support structures.

915.07.09.02 Steel

Salvaged steel components may be used as specified in the Contract Documents. A written certification bearing the seal and signature of an Engineer shall be submitted to the Contract Administrator certifying that salvaged components are defect free and are according to the Contract Documents.

915.07.09.03 Aluminum

Cracked or ruptured welds may be repaired. Distorted, cracked, or ruptured members or components shall be replaced subject to approval by the Contract Administrator as specified in the Contract Documents. Salvaged members shall not be used.

915.07.09.04 Inspection

An inspection of the repairs and replaced components shall be completed as specified in the Quality Control subsection.

915.07.10 As-Built Drawings

For overhead sign support structures, as-built drawings shall be prepared and submitted to the Contract Administrator in a reproducible format prior to final acceptance of the work and shall include the following information:

a) All work incorporated in the completed structure that required the submission of Working Drawings.

b) All changes that have been made from the original Contract Documents.

The as-built drawings shall bear the seal and signature of an Engineer.

915.07.11 Certificate of Conformance Upon Completion of the Work

Upon completion of the erection of the sign support structure, the Contractor shall submit to the Contract Administrator a certificate of conformance sealed, signed, and dated by the Quality Verification Engineer. The certificate shall state that the Work has been completed in general conformance with the Working Drawings and as specified in the Contract Documents.

915.07.12 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

915.08 QUALITY ASSURANCE

915.08.01 General

The Owner, at its discretion, may choose to do inspection, testing, and sampling in the fabricating shop and field to confirm that the materials supplied, the fabrication, and the erection have been completed as specified in the Contract Documents.

The Contractor shall provide a free and safe access, and protection from the weather for inspection and testing of materials and structural components, during all aspects of the fabrication, delivery, and erection of the sign support structures, at no additional cost to the Owner.

915.09 MEASUREMENT FOR PAYMENT

915.09.01 Actual Measurement

915.09.01.01 Sign Support Footings

For measurement purposes, a count shall be made of the number of sign support footings installed.

915.09.01.02 Sign Support Structures

For measurement purposes, a count shall be made of the number of sign support structures installed.

915.09.01.03 Attachment of Signs

For measurement purposes, a count shall be made of the number of signs installed.

915.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

915.10 BASIS OF PAYMENT

915.10.01 **Concrete in Ground Mounted Static Sign Support Footings, Tri-Chord and Cantilever - Item**
Concrete in Median Mounted Static Sign Support Footings Tri-Chord and Cantilever - Item
Concrete in Ground Mounted Variable Message Sign Support Footings - Item
Concrete in Median Mounted Variable Message Sign Support Footings - Item
Concrete in Steel Monotube Overhead Sign Support Footings - Item
Concrete in Steel Column Breakaway Sign Support Footings - Item
Concrete in Steel Column Non-Breakaway Sign Support Footings - Item
Tri-Chord Static Sign Support Structures, Span in Metres - Item
Cantilever Static Sign Support Structures, Class - Item
Steel Monotube Overhead Sign Support Structures, Span in Metres - Item
Variable Message Sign Support Structures, Span in Metres - Item
Steel Column Breakaway Sign Support Structures - Item
Steel Column Non-Breakaway Sign Support Structures - Item
Wood Column Breakaway Sign Support Structures - Item
Wood Column Non-Breakaway Sign Support Structures - Item
Aluminum Bridge Mounted Sign Support Structures - Item
Repair of Existing Structure - Item
Attachment of Sign - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

For payment purposes, the fabrication and delivery of the sign support structures to the work site shall constitute 60% of the work of the tender item.

Replacement of aluminum components that were cracked, ruptured, or damaged during fabrication or erection shall be at no additional cost to the Owner.

Appendix 915-A, November 2014
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Standard for galvanized fasteners. (915.05.03)
- Clamp details. (915.05.04)
- Standard for steel. (915.05.05)
- Concrete compressive strength. (915.05.06)
- Grade of wood. (915.05.08)
- Anchorage assembly bolt, stud, strut, coil, and galvanizing requirements. (915.05.09)
- Electrical duct and fitting requirements. (915.05.11)
- Granular backfill type. (915.05.12)
- Coating requirements. (915.05.13, 915.07.01.02.04)
- Site identification number, maximum sign area, and design wind pressure for each sign support. (915.07.01.04)
- Footing locations. (915.07.02.01)
- Excavation lines and grades. (915.07.02.02)
- Anchorage assembly level tolerances. (915.07.02.05)
- Rigid duct requirements in footings. (915.07.02.06)
- Concrete footing elevations. (915.07.02.07)
- Bolted field splices. (915.07.03.05)
- Fastener torque requirements. (915.07.03.06)
- Roadside sign support footing locations, dimensions, and elevations. (915.07.04.01)
- Steel column tolerances. (915.07.04.02.02)
- Steel column breakaway type top surface of the friction plate elevation. (915.07.04.02.03)
- Wood column tolerances. (915.07.04.03.01)

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- Site trimming and finishing around footings. (915.07.05)

- Locations of signboards to be installed by the Contractor. (915.07.06)

- Drain and vent hole locations. (915.07.07.03.01)

- Use of salvaged steel components. (915.07.09.02)

The designer should determine if the following is required and, if so, specify it in the Contract Documents:

- If ground lugs, fuse clips, and access nipples for wiring are to be installed during shop fabrication. (915.07.01.03)

- Delivery requirements for signboard chord clamps. (915.07.01.05.02)

- Rigid duct sleeves. (915.07.02.06)

OPSS 915 contains information that is not used by municipalities in their Contracts. To ensure completeness of the municipal Contract Documents, the designer should invoke Appendix 915-B. The appendix contains information that modifies OPSS 915 so it can be used by a municipality in its Contracts.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

Appendix 915-B, November 2014
FOR USE IN MUNICIPAL CONTRACTS, WHEN REFERENCED IN THE CONTRACT DOCUMENTS

Note: This is a non-mandatory Additional Information Appendix intended to provide supplementary requirements for the OPS specification in a municipal contract, when the appendix is invoked by the Owner. It is written in mandatory language to permit invoking it by reference in the Contract Documents. If the appendix has not been invoked by reference in the Contract Documents, it does not apply.

Supplemental Requirements for Using OPSS 915 in Municipal Contracts

OPSS 915, Sign Support Structures, is amended as follows:

915.03 DEFINITIONS

Section 915.03, the definition for Certificate of Conformance is deleted in its entirety and replaced with the following:

Certificate of Conformance means a document issued by an Engineer confirming that the specified components of the Work are in general conformance with the requirements of the Contract Documents.

Section 915.03, the definition for Quality Verification Engineer is deleted in its entirety.

915.04.02.02 Working Drawings for Sign Support Structures

The first paragraph of clause 915.04.02.02 is deleted in its entirety and replaced by the following:

The Contractor shall submit 5 sets of Working Drawings to the Contract Administrator at least 14 Days prior to commencement of fabrication of overhead sign support structures.

915.04.02.05 Erection Procedures for Overhead Sign Support Structures

The first paragraph of clause 915.04.02.05 is deleted in its entirety and replaced by the following:

The Contractor shall submit 5 copies of the erection procedures to the Contract Administrator at least 14 Days prior to the commencement of overhead sign support structure erection.

915.04.02 Submission Requirements

Clause 915.04.02 is amended by the addition of the following:

915.04.02.09 Return of Submissions - Working Drawings and Erection Procedures

Two copies of each submission shall be returned as one of the following:

a) Stamped with the wording that allows for permission to construct. In this case, work can commence on receipt of the working drawings or erection procedures by the Contractor.

b) Stamped with the wording that allows for permission to construct as noted. In this case, work can start on receipt of the working drawings or erection procedures by the Contractor. The working drawings or erection procedures shall be updated as noted and shall be sealed and signed by the design Engineer and the design-checking Engineer stating the drawings have been revised according to the noted comments.

c) Showing only required changes. In this case, the working drawings or erection procedures shall be updated as required and the submission process repeated.

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915.07.11 Certificate of Conformance Upon Completion of the Work

Clause 915.07.11 is deleted in its entirety and replaced by the following:

915.07.11 Certificate of Conformance

Upon completion of the erection of the sign support structure, the Contractor shall submit to the Contract Administrator a certificate of conformance bearing the seal and signature of an Engineer. The certificate shall state that the work has been completed in general conformance with the Working Drawings and as specified in the Contract Documents.

CONSTRUCTION SPECIFICATION FOR MODULAR BRIDGE STRUCTURES FOR TEMPORARY INSTALLATIONS

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918-A **Commentary**

918.01 SCOPE

This specification covers the requirements for the design, supply, construction, maintenance, and removal of modular bridge structures used for temporary installations, including ramps, bank seats, decking, sidewalks, and railings.

918.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

918.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

918.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 501	Compacting
OPSS 906	Structural Steel for Bridges
OPSS 907	Structural Wood Systems
OPSS 908	Metal Traffic Barriers and Metal Railings for Structures

Ontario Provincial Standard Specifications, Material

OPSS 1601	Wood, Preservative Treatment, and Shop Fabrication

Ontario Ministry of Transportation Publications

Structural Manual

CSA Standards

CSA S6-14	Canadian Highway Bridge Design Code

918.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Bank Seats means mud sills, timber matting and other components to support the base plates and ramps.

Certificate of Conformance means a form issued by an Engineer confirming that the specified components of the Work are in conformance with the Contract Documents.

Modular Bridge means a superstructure comprised of commercially available standard proprietary prefabricated components that can be assembled and disassembled on site.

Temporary Installation means an installation that maintains traffic at a construction site for a length of time not exceeding three years.

918.04 DESIGN AND SUBMISSION REQUIREMENTS

918.04.01 Design Requirements

The modular bridge structure shall be designed according to the Contract Documents, CSA S6 and the Structural Manual except that:

a) The following requirements of the CSA S6 are not mandatory:

   i. Traffic lane widths, side clearance, and sidewalks.
   ii. Deck crossfall and drain outlets.
   iii. Limitation of maximum deflection.
   iv. Designing floor beam and diaphragms for jacking.
   v. Provision of a protective coating.
   vi. Fatigue.
   vii. Accessibility for inspection and coating, the avoidance of pockets, and the provision of drain holes in pockets and their filling with waterproofing.
   viii. Camber.
   ix. Provision of two bolts at the end of bracing members.
   x. Nuts with safety pins or snap rings may be used instead of hexagonal recessed nuts or hexagonal solid nuts with washers.

b) In addition to the requirements of CSA S6, a minimum of three girders or two pairs of trusses shall be used to form the main load carrying system of the bridge.

918.04.02 Submission Requirements

918.04.02.01 Working Drawings, Procedures & Certifications

The following documents, bearing the seal and signature of a design Engineer and a design-checking Engineer, shall be submitted to the Contract Administrator at least 7 Days prior to commencement of the installation of the modular bridge, for information purposes only:

a) Working Drawings of the modular bridge.

b) Launching, installation and removal procedures.

c) A letter and design calculations certifying that the modular bridge has been designed according to the Contract Documents.

d) Where modular bridge components are fabricated outside of Canada, a letter shall be submitted certifying that the materials used, and the fabrication of the modular bridge components are according to the Contract Documents.

e) Where the load carrying capacity of the modular bridge or any of its components has been established by testing, the load test reports provided by the manufacturer of the modular bridge shall be submitted confirming the bridge satisfies the requirements of the Evaluation Section of CSA S6, using a Reliability Index (β) not less than 3.75.

Where previously used components are utilized in the modular bridge, a letter signed and sealed by an Engineer shall be submitted certifying that all used components are in good structural condition and free from any damage or defects that could adversely affect their load carrying capacity and performance.

When other authorities are involved in the approval of the design or construction of the modular bridge, submissions shall be made at least 5 weeks prior to commencement of the construction of the modular bridge and one additional copy of the submission shall be provided for each authority.

The requirements of each authority shall be satisfied prior to commencement of the construction of the modular bridge.

918.04.02.02 Notice of Installation

A written notice shall be submitted to the Contract Administrator at least 7 Days prior to the installation of the modular bridge superstructure.

918.05 MATERIALS

918.05.01 General

All materials and components shall be according to the Working Drawings.

918.05.02 Modular Bridge Components

All modular bridge steel components shall be fabricated according to the requirements of OPSS 906.

The use of modular bridge components that have been used previously is permitted provided they are free from damages or defects that could adversely affect their load carrying capacity and performance.

918.05.03 Hardware

The hardware used in the assembly and installation of the modular bridge shall be according to the modular bridge manufacturer's requirements.

918.05.04 Structural Steel

Any structural steel components that are not part of the modular bridge shall be designed and constructed according to OPSS 906.

918.05.05 Wood

Wood shall be according to OPSS 1601. Preservative treatment of wood is not required. Fasteners and hardware for wood construction shall be according to OPSS 907.

918.05.06 Railings

Railings shall be according to OPSS 908 or an equivalent modular bridge manufacturer railing system.

918.07 CONSTRUCTION

918.07.01 General

At least 7 Days prior to installation of the modular bridge, documentation indicating that the modular bridge supervisor who shall be in charge of the installation of the modular bridge has had experience and has successfully performed these duties on at least 3 similar bridges shall be submitted to the Contract Administrator.

918.07.02 Construction of Bank Seats

Fill under bank seats shall be compacted according to OPSS 501 to a minimum of 95% of the maximum dry density.

918.07.03 Installation and Removal of Modular Bridge

The modular bridge, including bank seats, shall be assembled, installed, and removed according to the Working Drawings, procedures and Contract Documents.

918.07.04 Inspection after the Completion of the Construction of the Modular Bridge Structure

A Certificate of Conformance shall be submitted to the Contract Administrator upon the completion of construction of the modular bridge structure.

918.07.04 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

918.07.05 Modular Bridge Maintenance

For the duration of the Contract, including seasonal shutdown, the contractor shall ensure the structural integrity, safety and performance of the modular bridge. This shall include, inspection, maintenance, and repair as required, of elements including but not limited to, bearings, bank seats, ramps, decking, sidewalks, railing, approaches, and substructure elements.

918.10 BASIS OF PAYMENT

918.10.01 Temporary Modular Bridge - Item

Payment at the Contract price for the above item shall be full compensation for all labour, Equipment, and Material to do the work.

For payment purposes, the construction of the modular bridge shall constitute 50% of the work of the tender item.

Appendix 918-A, November 2018
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

Note: The MUNI published in November 2021 replaces OPSS 919 COMMON, November 2011 with no technical content changes.

CONSTRUCTION SPECIFICATION FOR FORMWORK AND FALSEWORK

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919-A **Commentary**
919-B **Supplemental Requirements for Using OPSS 919 in Municipal Contracts**

919.01 SCOPE

This specification covers the design and construction requirements for formwork, falsework, and temporary supports used in the construction and rehabilitation of structures.

919.01.01 Specification Significance and Use

This specification has been developed for use in municipal-oriented Contracts. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

919.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

919.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 501	Compacting
OPSS 903	Deep Foundations
OPSS 906	Structural Steel

Ontario Provincial Standard Specifications, Material

OPSS 1010	Aggregates - Base, Subbase, Selected Subgrade, and Backfill Material
OPSS 1350	Concrete - Materials and Production
OPSS 1801	Corrugated Steel Pipe Products

CSA Standards

A23.3-04	Design of Concrete Structures
G40.20-04/40.21-04	General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel
G164-M92	Hot Dip Galvanizing of Irregularly Shaped Articles
O86-M84 (R1992)	Engineering Design in Wood
O121-08	Douglas Fir Plywood
O122-06	Structural Glued-Laminated Timber
S16-1969	Steel Structures for Buildings
S157/S157.1-05	Strength Design in Aluminum/Commentary on CSA S157-05, Strength Design in Aluminum
S269.1-1975 (R2003)	Falsework for Construction Purposes

S269.3-M92 (R2008) Concrete Formwork

National Research Council (NRC)

National Building Code of Canada-2005

919.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Bulkhead means the vertical form that supports the end width of a deck pour of concrete.

Certificate of Conformance means a document issued by the Quality Verification Engineer confirming that the specified components of the Work are in general conformance with the requirements of the Contract Documents.

Culvert means a structure that provides an opening through an embankment and in which roadway loads are distributed to the structure through fill or that is designated as a culvert in the Contract Documents.

Engineer means a professional engineer licensed by the Professional Engineers Ontario to practice in the Province of Ontario.

Exposed Surface means all external formed surfaces not to be covered by backfill material.

Falsework means any temporary structural support, including bracing, used to support all or part of the formwork or of the structure during its construction or rehabilitation until it becomes self-supporting.

Formwork means the mould into which the fresh concrete is placed.

Foundation means the ground immediately below the mudsills that supports the falsework or that portion of ground supporting the falsework piles.

Grade means:

a) For steel, the designation of the quality of the steel that can be determined by referring to the appropriate CSA standard or by specimen testing.

b) For wood, the designation of the quality of a piece of wood that can be determined by referring to the appropriate CSA Standard.

Hardwood means wood with a degree of hardness at least equal to a species, such as hard maple, oak, or beech.

Joist means one of a series of horizontal members, usually with narrow face up, to which form material is fastened.

Ledger means a horizontal flexural member usually supporting joists and resting on vertical supports.

Mudsill means a mat of timbers or a small footing on the ground used as a base from which the remainder of the falsework structure is erected.

Quality Verification Engineer (QVE) means an Engineer retained by the Contractor qualified to provide the services specified in the Contract Documents.

Shoring means a system of vertical or inclined supports for forms or structure components. Shoring may be wood or metal posts, scaffold-type frames, or various patented members or other system of falsework.

Stay-in-Place Forms means forms that are not removed.

Structure means any bridge, culvert, tunnel, retaining wall, wharf, dock, or guideway.

Stud means one of a series of usually vertical members used in framing to support the plywood or formwork fastened to it.

Timber means felled trees or logs suitable for conversion by sawing or otherwise or a piece of sawn lumber having a minimum nominal dimension greater than or equal to 125 mm.

Wood means lumber and timber.

919.04 DESIGN AND SUBMISSION REQUIREMENTS

919.04.01 Design Requirements

919.04.01.01 Formwork Design

Formwork design shall be according to CAN/CSA S269.3.

919.04.01.02 Falsework Design

Falsework design shall be according to CSA S269.1 and as specified herein.

The allowable stresses for wood design shall be according to CSA/CAN3-086.

The allowable stresses for structural steel design shall be according to CSA S16, except the stresses allowed may be increased by 15% for temporary loading.

Deflection of beams shall be limited to L/270, where L is the span. The loading for deflection shall be the weight of concrete and formwork.

When deflection of a beam is 10 mm or more, provision shall be made to compensate for deflection. When provision is made to compensate for deflection, the deflection of the beams shall be limited to L/240, where L is the span. The tolerance shall be ± 5 mm.

Aluminum components shall be designed according to CAN3-S157.

Concrete components shall be designed according to CSA A23.3.

Where scaffolding, fabricated shoring, or patented accessories are used, the design shall be according to the manufacturer's recommendations.

Where another authority is involved, any additional requirements specified by the authority shall also be satisfied.

919.04.01.03 Vertical Loadings

Vertical loading shall be:

a) The weight of the concrete being supported or 2.50 kN/m^2 on the horizontal projected area of the formwork, whichever is the greater.

b) The weight of normal concrete, as it is placed, shall be considered as a liquid having a weight of 24.00 kN/m^3.

c) The weight of the formwork supported by the falsework or 0.50 kN/m^2 of the horizontal projected area, whichever is greater.

d) The weight of workers, equipment, and tools that is to be supported during the concrete placing and finishing operations or 2.00 kN/m^2 of horizontal projected area of formwork whichever is greater. When motorized placing equipment is used this minimum load shall be increased to 3.00 kN/m^2.

e) Load due to any special conditions of construction likely to occur.

f) Loads for temporary supports as specified.

919.04.01.04 Horizontal Loading

The horizontal loadings shall include the effects of environmental factors, such as wind; the rate of placing of concrete; the temperature of the concrete; the effect of vibration of the concrete; the consistency of the mix; and other pertinent factors.

Wind pressures shall be based on those listed in the National Building Code of Canada using 1/30 probability for falsework and 1/10 probability for formwork with a gust factor of 2 and a minimum wind pressure of 0.8 kPa.

Notwithstanding the above, a minimum transverse and longitudinal force of 2% of vertical loading or 1.50 kN/m of deck edge applied at the mid-depth of the deck, whichever is greater, shall be used.

919.04.01.05 Tower Leg Loads

The vertical loads on the tower legs may be based on simple span assumptions. The loads supported by a tower leg may be assumed to be those loads applied to the area immediately above the tower leg that is bounded by lines located one halfway between each of the bays adjacent to the tower leg being considered.

When locating towers, the following criteria shall apply:

The maximum design load on one leg of a frame shall not exceed four times the design load on the other leg under full or partial loading conditions.

The maximum design load on one of the two frames making up a tower shall not exceed four times the design load on the opposite frame under any loading condition.

919.04.01.06 Minimum Bracing Requirements

The minimum bracing requirements are as follows:

a) Connections Between Joists and Ledgers

Every fourth joist shall be connected to a ledger.

Ledgers on top of frames shall be axially continuous across the shoring system to evenly distribute horizontal forces to individual scaffold towers below. Ledgers with a splice designed to take the axial load are considered axially continuous.

b) Bracing in the Transverse Direction

When the shoring height is composed of three frames or the shoring height is more than three times the tower width or the total shoring height is more than 5 m, one horizontal brace made continuous shall be installed on one face of each tower.

The brace shall be located at the mid-height of a two-frame tower and at the top of the second frame for a three-frame tower.

When shoring towers are adequately braced against transverse movement by tying to an adjacent structure or adjacent tower, the above height-to-width restriction applies only to the tower grouping.

When the shoring height is composed of more than three frames, at least one horizontal brace made continuous and one diagonal brace made continuous shall be attached to one transverse face of each tower for every three frames of shoring height. In addition, the maximum spacing of the horizontal brace shall be three times the tower width. The horizontal brace shall be located near the top of a frame. Diagonal braces on adjacent towers shall be installed in opposite directions.

When superelevation is 4% or greater, a horizontal transverse brace shall be attached to one tower face of the top frame in addition to the bracing required by the preceding paragraph.

When the shoring height is greater than 20 m, guy wires shall be installed. The spacing of the guy wires shall not be greater than 15 m horizontally.

c) Bracing in the Longitudinal Direction

When the shoring height is composed of three frames or the total height is more than 5 m, one horizontal brace made continuous shall be installed spaced horizontally not more than 6 m apart. The brace shall be located at the top of the first frame of a two-frame tower and the top of the second frame of a three-frame tower.

When the shoring height is composed of four frames or more, horizontal braces and diagonal braces made continuous shall be attached on a tower and spaced horizontally not more than 6 m apart. The lowest brace shall be located no higher than the third frame and additional braces shall be spaced vertically at the top of every third frame thereafter.

When the bridge is on a longitudinal grade of 4% or greater, braces parallel to the grade shall be attached to one tower face of the top frame and spaced not more than 6 m apart horizontally.

d) Tie Back Bracing - Falsework Opening Towers

The falsework opening towers shall be longitudinally braced to two rows of scaffold towers behind them according to the Bracing in the Longitudinal Direction requirements above, regardless of the height, and shall be continuously braced transversely.

919.04.01.07 Mudsills

The mudsills shall be designed such that the settlement of mudsills shall not exceed 12 mm.

919.04.02 Submission Requirements

919.04.02.01 Working Drawings

919.04.02.01.01 General

Working Drawings shall be submitted for all falsework used in the construction or rehabilitation of structures, except for culverts less than 3 m in span.

Working Drawings are required for the following formwork:

a) Inside forms for post-tensioned decks;

b) Bulkheads in post-tensioned decks 2.0 m or greater in height;

c) All columns and walls, 2.4 m or greater in height, of abutments, piers, and retaining walls.

Working Drawings for other formwork shall only be submitted, when specified in the Contract Documents.

Formwork and falsework shall not be supported by, braced to, or come in contact with another structure unless written permission is received from the owner of the other structure. In order to obtain written permission, 3 copies of Working Drawings shall be submitted to the owner of the other structure showing the support locations and imposed loads as they are applied to that structure and certify that the structure can safely support all the imposed loads from the Contractor's method of construction. Prior to a submission, an Engineer's seal and signature shall be affixed on the Working Drawings verifying that the drawings are consistent with the Contract Documents.

During formwork and falsework construction, the Contractor shall have a copy of the Working Drawings at the site.

919.04.02.01.02 Falsework

The Contractor shall submit 3 sets of falsework Working Drawings to the Contract Administrator at least 1 Day prior to commencement of erection of falsework, for information purposes only. Prior to making a submission, the seals and signatures of a design Engineer and a design-checking Engineer shall be affixed on the Working Drawings verifying that the drawings are consistent with the Contract Documents.

Where multi-discipline engineering work is depicted on the same Working Drawing and the design or design-checking Engineer or both are unable to seal and sign the Working Drawing for all aspects of the work, the drawing shall be sealed and signed by as many additional design and design-checking Engineers as necessary.

When other authorities are involved, 1 set of Working Drawings shall be submitted for each authority at least 5 weeks prior to the commencement of falsework construction.

The Working Drawings for the falsework for each structure shall include all details of all falsework to be erected.

Falsework Working Drawings shall include at least the following:

a) Longitudinal, lateral, vertical, live, impact, and anticipated construction loads used in the design.

b) Allowable bearing capacity of the soil beneath the mudsills.

c) Maximum column loads.

d) Deflection diagrams for beams having a deflection of 10 mm or more.

e) The grade and actual size of all structural materials.

f) Posts, connections, bracing and welding sufficiently detailed to demonstrate compliance with the structural analysis and erection requirements.

g) Fully detailed frame shoring.

h) Type and mass of moving or stationary equipment to be supported by the falsework.

i) Sequence, method, and rate of concrete placement.

j) All proprietary equipment sufficiently identified to demonstrate compliance with the structural analysis and erection requirements.

k) Full details and locations of all splices.

l) Method of maintaining rotational and lateral stability of bridge girders.

m) Vertical stiffening details and lateral restraint for ledgers and subledgers.

n) Lateral restraint details for falsework supporting beams spanning openings.

o) Fluid concrete loads, assumed for design purposes.

p) Location of screed rail supports and design load.

q) Anticipated settlement of falsework, including settlement of mudsill.

919.04.02.01.03 Formwork

The Contractor shall submit 3 sets of formwork Working Drawings to the Contract Administrator at least 1 Day prior to commencement of erection of formwork, for information purposes only. Prior to making a submission, the seals and signatures of a design Engineer and a design-checking Engineer shall be affixed on the Working Drawings verifying that the drawings are consistent with the Contract Documents and sound engineering practices.

Where multi-discipline engineering work is depicted on the same Working Drawing and the design or design-checking Engineer or both are unable to seal and sign the Working Drawing for all aspects of the work, the drawing shall be sealed and signed by as many additional design and design-checking Engineers as necessary.

When other authorities are involved, 1 set of Working Drawings shall be submitted for each authority at least 5 weeks prior to the commencement of falsework construction.

The Working Drawings shall show all necessary design and construction details, including the grade and size of materials used and the pressure diagrams used in the design.

919.04.02.02 Foundation Information

919.04.02.02.01 Falsework Foundation Design Report

Three copies of a Falsework Foundation Design Report shall be submitted to the Contract Administrator. The report shall bear the seal and signature of an Engineer, shall include the rationale used to determine the soil bearing capacity, and shall include the following information:

a) The soil bearing capacity.

b) Site preparation details.

A Falsework Foundation Design Report is not required when the mudsill bears on mass concrete poured directly on bedrock or when the mudsill bears on compacted Granular A of depth 1.0 m or less placed directly on bedrock.

919.04.02.02.02 Interim Inspection after Construction of Falsework Foundation

Upon completion of the falsework foundation and prior to installation of falsework, the Quality Verification Engineer shall conduct an interim inspection of the work to verify that the falsework foundation has been constructed according to the Falsework Foundation Design Report and issue the Contractor written permission to proceed with the work.

919.04.02.03 Proprietary Shoring, Forms, and Accessories

When proprietary shoring, forms, and accessories are used, the manufacturers' allowable loads with supporting test data shall be submitted with the Working Drawings.

919.04.02.04 Splices for Stay-In-Place Forms

Details of the method of joining round stay-in-place forms shall be shown on the Working Drawings.

919.04.02.05 Revised Submissions

When falsework design considerations or field conditions necessitate amendments to the falsework, revisions shall be resubmitted according to the Working Drawings clause.

919.05 MATERIALS

919.05.01 General

Forms and falsework shall be constructed of wood, metal, or concrete.

919.05.02 Wood

Wood shall be according to CSA/CAN3-O86.

919.05.03 Plywood

Plywood for formwork shall be 7 ply, 17 mm minimum thickness exterior grade Douglas Fir Plywood according to CSA O121.

For exposed surfaces, the finish side shall be medium density overlay plywood; however, this finish is not required in the following locations:

a) The underside of a deck between girders.

b) The ends of decks.

c) The face of ballast walls.

d) The internal faces of a culvert.

919.05.04 Structural Glued-Laminated Timber

Structural glued-laminated timber shall be exterior grade according to CAN/CSA O122.

919.05.05 Metal

Structural steel shall be according to CAN/CSA G40.20/G40.21 and be of the grade shown on the Working Drawings.

Aluminum shall be according to CSA-S157 and be of the alloy and temper shown on the Working Drawings.

Used metal shall be in good condition. All previous fabrication, adversely affecting the required strength, shall be corrected.

919.05.06 Concrete

Concrete shall be according to OPSS 1350.

919.05.07 Accessories

All accessories used shall comply with the details shown on the Working Drawings or with the recommendations of the manufacturer of the specified accessory.

Deck hangers and hardware left in place, either exposed or embedded in concrete within 20 mm of its surface, shall be hot dip galvanized.

All form ties left in place in barrier and parapet walls shall be hot dip galvanized, coated with an approved material, or non-corrodible. Where stainless steel reinforcement is used within the form, all form ties left in place in barrier and parapet walls shall be of stainless steel type 304.

The maximum diameter of plastic cones for form ties shall be 30 mm.

Hot dip galvanizing shall be according to CAN/CSA G164-M.

919.05.08 Void Tubes

Corrugated steel pipe shall be according to OPSS 1801 and need not be coated.

The thickness of the plate in the corrugated pipe shall be as follows:

a) Diameters equal to or less than 900 mm - 0.9 mm thick.

b) Diameters over 900 mm to 1200 mm - 1.1 mm thick.

Steel void forms shall have an outside diameter, top of corrugation to top of corrugation, equal to the diameter of the voids shown on the Working Drawings.

Paper fibre tubes shall be coated, spiral wound, wood fibre paperboard manufactured with waterproof glue.

919.05.09 Granular A

Granular A shall be according to OPSS 1010.

919.07 CONSTRUCTION

919.07.01 Formwork

919.07.01.01 General

Forms shall be smooth; clean; free from warps, splits, holes, and bulges; and constructed and maintained to be mortar tight.

919.07.01.02 Exposed Surfaces

Forms for exposed surfaces shall be new, except that forms may be re-used for exposed surfaces providing their condition is such as to produce a surface equal to one that would be attained using new materials. Where possible, plywood used on exposed surfaces shall be in full sheets and, except when used to form the underside of deck slabs for slab-on-girder construction, shall be so arranged that the face grain is perpendicular to the studs or joists.

919.07.01.03 Studs, Joists, and Decking

Studs and joists shall be spaced not more than 400 mm on centres. Edges of abutting sheets shall be nailed to the same stud or joist with 50 mm nails at not more than 200 mm centres. When used to form the underside of deck slabs in post-tensioned slab and rigid frame bridges, the joints between sheets abutting over joists shall be staggered a minimum of 400 mm. When prefabricated form panels are used, adjacent panels shall be placed such that the joints are maintained flush.

919.07.01.04 Form Release Oil

Non-staining form release oil shall be applied to the faces of forms against which concrete is to be placed. The form release oil shall be applied before placing reinforcement.

919.07.01.05 Ties

When internal form ties are used, concrete cover to any metal left upon removal of the forms shall be 20 mm minimum.

All ties, securing stay-in-place forms in position and extending below the deck soffit shall be loosened before any stressing commences.

Holes left in the deck soffit after removal of hanger coil rods shall be left open.

919.07.01.06 Exposed Corners

All exposed corners on concrete work and the edges of the box void slabs on the soffit of the structure shall be chamfered. The chamfer shall have a vertical and horizontal dimension of 20 mm.

919.07.01.07 Stay-in-Place Forms

Stay-in-place forms shall only be used when specified in the Contract Documents or under the following conditions:

a) Round void tubes of metal in cast-in-place hollow prestressed concrete decks and round void tubes of metal or paper fibre in precast prestressed hollow slab deck units.

   Where round voids are used, individual lengths shall be joined by an inner or outer sleeve or other method. Details of the method of joining shall be submitted to the Contract Administrator, for information purposes only.

b) Box voids in precast concrete box girder deck units less than 1.2 m in depth.

919.07.02 Falsework

919.07.02.01 General

Sound adjustable falsework shall be built such that the structure remains true to line and grade after anticipated settlement.

Mudsills shall not be placed until the Contractor has a set of falsework Working Drawings on site.

The use of tack welds for hangers or other attachments to structural steel is not allowed, except that tack welds may be used on shear studs where it is not detrimental to the connection between the stud and the structural steel.

All welding of structural steel shall be according to OPSS 906.

919.07.02.02 Foundation Work

The falsework structure shall be supported on mudsills, structure footings, or piles.

Where the existing ground is unable to take the applied loads, piles driven according to OPSS 903 shall be used to support the falsework.

Where a timber pile in a falsework bent is too short, the Contractor shall cut off all the piling in the bent to the same elevation and cap the bent. An extension bent shall then be constructed. A pile splice shall only be used with the approval of the Contract Administrator.

Where steel piles are used in a falsework bent, a splice designed and fabricated for 100% of the pile section may be used to make up the required length of any pile.

All caps shall be continuous for the entire length of the bent or sliced as approved by the Contract Administrator. When splices in caps are approved, they shall be located at the centreline of a pile.

For traffic openings, a minimum horizontal space of 1.0 m shall be provided between the back face of the concrete barrier and the front edge of the mudsill.

A levelling pad consisting of a minimum of 100 mm of Granular A, compacted according to OPSS 501, or of poured in place concrete shall be placed under mudsills on bedrock to provide a level surface.

Where the ground is sloped and the Contractor elects to excavate steps, the slopes between the horizontal steps shall not be steeper than 1H:1V. A minimum horizontal width of 300 mm shall be provided between the mudsill and the top edge of slope.

Reduction of the bearing capacity of existing ground or compacted fill, due to water or ice, shall be prevented by suitable drainage or protection.

919.07.02.03 Wooden Shoring

All wooden posts shall be solid, not built up. Where splicing is necessary, the posts shall be cut square and the two pieces shall be in full contact over the splice. Scabbing shall be provided on all four faces of a post to be spliced. Each post shall be braced in two directions both above and below the splice immediately adjacent to the scabbing. Splices on adjacent posts shall be staggered.

Splicing of round posts shall not be permitted.

Bracing material shall be at least 38 x 89 mm lumber except for cross bracing for side forms where 19 x 138 mm lumber may be used. Bracing shall be nailed to each post with at least two 100 mm nails for 38 x 89 mm lumber and two 75 mm nails for 19 x 138 mm lumber. Splicing of bracing shall not be permitted.

Wedges used for purposes of falsework adjustment or to facilitate removal shall be hardwood.

919.07.02.04 Metal Shoring

Erection of metal frame shoring shall be according to CSA S269.1.

The maximum extension of jacks shall not exceed the lesser of the manufacturer's recommendations or 600 mm.

Shims used for levelling mudsills shall be fir plywood or solid lumber.

Wedges used to provide full bearing in U-heads shall be hardwood.

919.07.03 Temporary Supports

The construction of temporary supports shall be as specified in the Contract Documents.

919.07.04 Screed Rail Supports in Slab on Girder Construction

In slab-on-girder construction, screed rail supports shall not be located outside the centreline of the web of the outside girders.

When screed rail supports are not located over the webs of girders, a system of support shall be installed such that the deflection of the system under the load of the screed machine shall not exceed 5 mm.

919.07.05 Certificate of Conformance

Certificates of Conformance shall be submitted for all formwork and falsework for which Working Drawings are submitted.

A completed Certificate of Conformance shall be submitted to the Contract Administrator upon completion of formwork and falsework installation and before any concreting takes place. The Qualification Verification Engineer’s seal and signature shall be affixed on the completed Certificate of Conformance confirming that the formwork and falsework have been installed in general conformance with the Working Drawings and Contract Documents.

919.07.06 Removal of Formwork, Falsework, and Temporary Supports

All formwork and falsework shall be removed. When authorized by the Contract Administrator, piles used for falsework may be left in place provided the top is 1.2 m below the finished grade or ground level or is at least 0.6 m below a streambed.

The method and sequence of removal of the formwork and falsework shall be such that it permits the concrete to take up the stresses gradually.

Falsework shall not be removed from post-tensioned structures until the post-tensioning is completed.

When a component is not post-tensioned, falsework may be removed after the concrete has attained a minimum strength of 20 MPa.

Formwork shall not be removed until the concrete has attained a minimum strength of 20 MPa; however, formwork for cast-in-place barrier walls and parapet walls may be removed 24 hours after completion of the placement.

Where insulation is used, the side forms may be slackened off 24 hours after concrete placement to help control temperature.

Removal of temporary supports shall be as specified in the Contract Documents.

919.07.07 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

919.10 BASIS OF PAYMENT

919.10.01 Formwork and Falsework

The Contract price for the concrete tender item directly associated with formwork and falsework shall include full compensation for all labour, Equipment, and Material to do the work.

919.10.02 Temporary Support - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the Work.

Appendix 919-A, November 2021
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Stay-in-place forms. (919.07.01.07)

- Construction of temporary supports. (919.07.03)

- Removal of temporary supports. (919.07.06)

The design should determine if the following is required and, if so, it should be specified in the Contract Documents:

- Submissions of other formwork Working Drawings. (919.04.02.01.01)

OPSS 919 contains information written for provincial contracts. To ensure completeness of municipal Contract Documents, the designer should invoke Appendix 919-B. The appendix contains supplemental requirements that modify OPSS 919 so it can be used by a municipality in its contracts.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 3310.100	Deck, Girders, Concrete, Method of Obtaining Screed Elevations
OPSD 3311.100	Deck, Girders, Steel, Method of Obtaining Screed Elevations
OPSD 3332.100	Deck, Round Voids, Form Supports and Tie Downs
OPSD 3333.100	Deck, Round Voids, Drains
OPSD 3333.101	Deck, Trapezoid Voids, Drains
OPSD 3390.100	Deck, Drip Channel
OPSD 3390.150	Falsework Clearance to Traffic Lanes
OPSD 3940.150	Figures In Concrete, Warning Message, Layout
OPSD 3940.151	Figures In Concrete, Warning Message Letters
OPSD 3940.200	Figures In Concrete, Site Number and Date Layout

Appendix 919-B, November 2009
FOR USE IN MUNICIPAL CONTRACTS, WHEN REFERENCED IN THE CONTRACT DOCUMENTS

Note: This is a non-mandatory Additional Information Appendix intended to provide supplementary requirements for the OPS specification in a municipal contract, when the appendix is invoked by the Owner. It is written in mandatory language to permit invoking it by reference in the Contract Documents. If the appendix has not been invoked by reference in the Contract Documents, it does not apply.

Supplemental Requirements for Using OPSS 919 in Municipal Contracts

OPSS 919, Formwork and Falsework, is amended as follows:

919.03 Definitions

Section 919.03 is amended by the deletion of the definitions for Certificate of Conformance and for Quality Verification Engineer.

Section 919.03 is amended by the addition of the following:

Certificate of Installation means a document issued by the design Engineer or design-checking Engineer confirming that the specified components of the Work are in general conformance with the requirements of the Contract Documents.

919.04.02.01.02 Falsework

The first paragraph of clause 919.04.02.01.02 is deleted in its entirety and replaced by the following:

The Contractor shall submit 5 sets of Working Drawings to the Contract Administrator at least 14 Days prior to commencement of the erection of falsework. Prior to making a submission, the seals and signatures of a design Engineer and a design-checking Engineer shall be affixed on the Working Drawings verifying that the drawings are consistent with the Contract Documents.

919.04.02.01.03 Formwork

The first paragraph of clause 919.04.02.01.03 is deleted in its entirety and replaced by the following:

The Contractor shall submit 5 sets of Working Drawings to the Contract Administrator at least 14 Days prior to commencement of the erection of formwork. Prior to making a submission, the seals and signatures of a design Engineer and a design-checking Engineer shall be affixed on the Working Drawings verifying that the drawings are consistent with the Contract Documents.

919.04.02.02.02 Interim Inspection after Construction of Falsework

Clause 919.04.02.02.02 is deleted in its entirety and replaced by the following:

Upon completion of the falsework foundation and prior to installation of falsework, the design Engineer or the design-checking Engineer shall conduct an interim inspection of the work to verify that the falsework foundation has been constructed according to the Falsework Foundation Design Report and issue the Contractor written permission to proceed with the work.

Appendix 919-B

919.04.02 Submission Requirements

Subsection 919.04.02 is amended by the addition of the following:

919.04.02.06 Return of Submissions

Two copies of each submission shall be returned as one of the following:

a) Stamped with the wording that allows for permission to construct. In this case, work can commence on receipt of the drawings by the Contractor.

b) Stamped with the wording that allows for permission to construct as noted. In this case, work can start on receipt of the drawings by the Contractor. The drawings shall be updated as noted and shall be sealed and signed by the design Engineer and the design-checking Engineer stating the drawings have been revised according to the noted comments.

c) Showing only required changes. In this case, the drawings shall be updated as required and the submission process repeated.

919.07.05 Certificate of Conformance

Clause 919.07.05 is deleted in its entirety and replaced by the following:

919.07.05 Certificate of Installation

Certificates of installation shall be submitted for all formwork and falsework for which Working Drawings are submitted.

A completed certificate of installation shall be submitted to the Contract Administrator upon completion of the formwork and falsework installation prior to the placement of concrete. The design Engineer or design-checking Engineer's seal and signature shall be affixed on the completed certificate of installation confirming that the formwork and falsework have been installed in general conformance with the Working Drawings and Contract Documents. The certificate of installation shall also certify that the interim milestone inspections have been completed as specified in the Contract Documents.

CONSTRUCTION SPECIFICATION FOR DECK JOINT ASSEMBLIES, PREFORMED SEALS, JOINT FILLERS, JOINT SEALS, JOINT SEALING COMPOUNDS, AND WATERSTOPS - STRUCTURES

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920-A **Commentary**

920.01 SCOPE

This specification covers the installation and modification of deck joint assemblies and the placing of preformed seals, joint fillers, joint seals, joint sealing compounds, and waterstops.

920.01.01 Specification Significance and Use

This specification has been developed for use in provincial- and municipal-oriented Contracts. The administration, testing, and payment policies, procedures, and practices reflected in this specification correspond to those used by many municipalities and the Ontario Ministry of Transportation.

Use of this specification or any other specification shall be according to the Contract Documents.

920.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

920.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 501	Compacting
OPSS 904	Concrete Structures
OPSS 914	Waterproofing Bridge Decks with Hot Applied Asphalt Membrane
OPSS 922	The Installation of Bearings
OPSS 929	Abrasive Blast Cleaning - Concrete Construction

Ontario Provincial Standard Specifications, Material

OPSS 1010	Aggregates - Base, Subbase, Select Subgrade, and Backfill Material
OPSS 1204	Polyvinyl Chloride Waterstops
OPSS 1210	Deck Joint Assemblies
OPSS 1212	Hot Poured Rubberized Asphalt Joint Sealing Compound
OPSS 1302	Water
OPSS 1308	Joint Filler In Concrete
OPSS 1350	Concrete - Materials and Production

ASTM International

C 494M-99a	Standard Specification for Chemical Admixtures for Concrete
C 1017M-98	Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete
D 1056-00	Standard Specification for Flexible Cellular Materials, Sponge or Expanded Rubber

920.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Armouring Angle means as defined in OPSS 1210.

Bearing means as defined in OPSS 922.

Block-out means a cavity created to permit the installation of deck joint assemblies.

Elastomer means as defined in OPSS 1210.

Engineer means a professional engineer licensed by the Professional Engineers Ontario to practice in the Province of Ontario.

Joint Seal means ethyl vinyl acetate foam.

Joint Sealing Compound means a hot applied material, that is not preformed, used to seal a joint.

Nosing Angle means as defined in OPSS 1210.

Preformed Seal means as defined in OPSS 1210.

Product Drawings means drawings prepared by the manufacturer that have been approved by the Owner for use with the product.

Trial Installation means an installation designated by the Owner for the purpose of proving the performance of a particular joint system.

Upturn means an upward vertical change in direction of the seal at the gutter lines.

920.04 DESIGN AND SUBMISSION REQUIREMENTS

920.04.01 Design Requirements

920.04.01.02 Deck Joint Assembly Working Drawings

920.04.01.02.01 Drawing Content

The deck joint assembly Working Drawings shall clearly indicate the following:

a) Material properties.

b) Dimensions.

c) Connection attachments.

d) Injection hose system components and name of approved injection company.

e) Shop, field, and stage construction splices.

f) Fasteners and accessories.

g) Installation details.

h) Individual alpha-numeric identification number for each stage of installation.

i) Handling procedures including lifting points.

j) Manufacturer's recommended installation procedure for achieving the required bolt tension specified in the Contract Documents.

The deck joint assembly Working Drawings shall be according to the Contract Documents and product drawings and shall bear the seal and signature of an Engineer with 5 years experience in either or both of the fabrication or installation of expansion joints certifying conformance with the Contract Documents and product drawings.

920.04.01.02.01.01 Deck Joint Assembly Modification

In addition to the requirements of the previous clause, where a deck joint assembly is to be placed over an existing joint, the deck joint assembly Working Drawings shall show all connection details between the new and the existing deck joint assemblies.

920.04.02 Submission Requirements

920.04.02.01 Notice of Manufacturer

The Contractor shall notify the Contract Administrator, in writing, of the name and address of the manufacturer of the deck joint assembly within 30 Days of the Contract award.

920.04.02.02 Submissions of Drawings

Five sets of the deck joint assembly Working Drawings and 2 copies of the product drawings shall be submitted to the Contract Administrator 3 weeks prior to fabrication.

920.04.02.02.01 Return of Submissions

Two copies of the deck joint assembly Working Drawings to be returned shall be marked as one of the following:

a) Stamped with the wording that allows for permission to construct.

In this case, work can commence on receipt of the drawing by the Contractor. A copy of these drawings shall be available at the site prior to and during construction.

b) Stamped with the wording that allows for permission to construct as noted.

In this case, work can start on receipt of the drawings by the Contractor. The drawings shall be updated as noted and shall have a stamp affixed that is signed by an Engineer stating the drawings have been revised according to the noted comments. A copy of the stamped updated drawings shall be available at the site prior to and during construction.

c) Showing only required changes.

In this case, the drawings shall be updated as required and the submission process repeated.

920.04.02.03 Manufacturer’s Installation Procedures

Two copies of the manufacturer's recommended installation procedures for the deck joint assemblies and data sheets shall be submitted to the Contract Administrator, 7 Days prior to the application of the hot applied joint sealing compound and trial installations of the deck joint assembly.

920.04.02.04 Cold Weather Protection for Epoxy Injection

One week prior to the commencement of epoxy injection of the deck joint assembly in cold weather, a description of the method to be used to control the concrete temperature shall be submitted to the Contract Administrator. The submission shall be accompanied by samples of insulation when requested by the Contract Administrator. The description shall contain the following information:

a) Weather conditions for which the description applies.

b) Type of insulation, R value, and number of layers to be used.

c) Description of housing and heating.

d) Method of protection employed to effectively maintain the concrete temperature above 5 °C in the expansion joint blockout during the injection and continuously for a period of 48 hours after epoxy injection.

920.04.02.05 Field Dimensions

Prior to the commencement of fabrication of the deck joint assembly, the Contractor shall submit drawings to the Contract Administrator indicating the actual dimensions at the existing deck joint assembly locations.

920.05 MATERIALS

920.05.01 Preformed Seals

Preformed seals shall be according to OPSS 1210.

920.05.02 Joint Fillers

Joint fillers shall be according to OPSS 1308.

920.05.03 Joint Seals and Joint Sealing Compounds

Joint seals shall be according to ASTM D 1056 for ethyl vinyl acetate foam. The top surface of the ethyl vinyl acetate foam shall be embossed with the manufacturer's name and product identification.

Joint sealing compounds shall be according to OPSS 1212.

920.05.04 Lubricant

The lubricant shall be water soluble, non-adhesive, and non-staining. Lubricants used between the steel components and preformed seals shall not be deleterious to the joint materials or the surrounding concrete.

920.05.05 Deck Joint Assemblies

Deck joint assemblies shall be according to OPSS 1210.

920.05.06 Concrete

Concrete in which the deck joint assemblies are embedded shall be according to OPSS 1350 with a nominal minimum 28-Day compressive strength of 30 MPa, except as amended below:

a) The nominal maximum size of coarse aggregate for concrete shall be 13.2 mm.

b) Superplasticized concrete shall be used in expansion joints with cross slopes of 4% or less.

The Contractor shall supply a certificate from the manufacturer of the superplasticizer verifying that the superplasticizer meets the following requirements:

i. Is according to ASTM C 494M and C 1017M.
ii. Contains no chlorides.
iii. Is compatible with the cementing materials and all other materials in the concrete.

c) The concrete shall have an initial slump of 40 mm $\pm$ 20 mm. This slump shall be increased when required by the addition of the superplasticizer at the site according to the written instructions of the superplasticizer manufacturer. After the addition of the superplasticizer, the air content shall be 8.0% $\pm$ 1.5% and the slump shall be 150 mm $\pm$ 30 mm.

920.05.07 Bonding Agent

Bonding agent shall be according to OPSS 904.

920.05.08 Granular Materials

Granular A shall be according to OPSS 1010.

920.05.09 Antiseize Compound

Antiseize compound shall be according to OPSS 1210.

920.05.10 Water

Water shall be according to OPSS 1302.

920.05.11 Waterstops

Waterstops shall be according to OPSS 1204.

920.07 CONSTRUCTION

920.07.01 Installation of Deck Joint Assemblies

920.07.01.01 General

Concrete work is part of this item and except as specified herein shall be according to OPSS 904.

Deck joint assemblies shall be installed according to the stamped deck joint assembly Working Drawings.

Any damage to the corrosion protection system, including surface areas of field welds, shall be repaired with two coats of brush applied zinc rich coating applied according to the coating manufacturer's recommendations.

The threaded portion of the bolts and the underside of bolt heads shall be liberally coated with an antiseize compound immediately prior to installation.

The bolts that have been fully tensioned and require removal after final installation shall not be reused to fasten the clamping bars.

For modular expansion joint installation, the Contractor shall inform the joint manufacturer 7 Days prior to the joint installation, so that the manufacturer's representative is present on site during the installation to advise on the proper installation procedure.

920.07.01.01.01 Traffic Restrictions

Traffic, including construction traffic, shall not be permitted on any part of each stage of the deck joint assembly until all of the following conditions are met:

a) Concrete has cured for 7 Days.

b) Concrete has attained a minimum compressive strength of 25 Mpa.

c) Epoxy injection has been completed.

d) Epoxy has cured for a minimum of 24 hours.

e) For cold weather, epoxy has cured for 48 hours after epoxy injection or the curing time as specified in the manufacturer's data sheet.

f) For Type A joints, the clamping bars have been installed.

920.07.01.02 Protection

The deck joint assembly shall be lifted by nylon slings placed at the lifting points indicated on the stamped deck joint assembly Working Drawings.

During storage, the deck joint assembly shall be protected from dirt and deleterious materials, and stored so that distortion cannot occur. The deck joint assembly shall be supported on wood blocking spaced a maximum of 2 m apart.

920.07.01.03 Splicing

The location and number of field and stage construction splices and method of splicing of metal components shall be as detailed on the stamped deck joint assembly Working Drawings. For new construction, when the length of the expansion joint is greater than 15 m and a splice is required, a splice shall be located at a lane demarcation line near the centre line of the structure.

The preformed seal shall be continuous with no splices.

920.07.01.04 Placing

The deck joint assemblies shall be placed after the asphalt paving operation has been completed.

A block-out shall be formed for the deck joint assembly during concrete construction of the deck, ballast wall, and barrier wall. When new barrier walls are to be constructed, bulkheads shall be used to form block-outs in the barrier wall for the deck joint assemblies. The dimensions of the block-out in the barrier wall shall not be greater than those of the block-out in the deck and ballast wall, except for the modular joints in structures. The removal of existing concrete required to prepare the block-out shall be carried out prior to the paving operation.

Prior to filling the block-out, the expansion joint gap shall be plugged. The method used to plug the gap shall accommodate the anticipated movement and retain the fill material in the block-out during the period of traffic maintenance. The block-out shall be filled to the top of the deck prior to asphalt paving with granular A compacted according to OPSS 501.

When traffic is to be maintained over the block-out prior to asphalt paving, the granular A shall be capped with 50 mm of bituminous cold mix or hot mix. The top surface of the bituminous mix shall be maintained smooth and level with adjacent concrete and shall not ravel.

The limits of the block-out shall be accurately marked to be visible after paving. The paving operation shall be continuous over the area, which includes the deck, approach slabs, and 20 m beyond the end of each approach slab. Transverse joints in the asphalt pavement shall not be permitted.

Except when traffic is to be maintained over the unfinished joint, all material used to fill the block-out shall be removed within 5 Working Days after the block-out material is placed. The new asphalt pavement shall be sawcut full depth at the limits of the block-out. The asphalt from the block-out areas shall be removed and temporary wood angles with a minimum thickness of 19 mm shall be placed to protect the sawcut asphalt edges for the full depth of asphalt. Asphalt residue shall be cleaned from the reinforcing bars. All the material used to plug the expansion gap and to fill the block-out shall then be removed to the depth of the bearing seat.

Prior to placing the reinforcing steel, the concrete faces of the block-out shall be abrasive blast cleaned according to OPSS 929. After completion of this work, the deck joint assembly shall be placed in the block-out 3 mm below the elevation of asphalt pavement and in the position specified in the deck joint assembly Working Drawings.

Immediately prior to placing the concrete in the block-out, the top setting devices shall be adjusted to give the specified setting width required by the stamped deck joint assembly Working Drawings. The setting devices shall then be tightened and the deck joint assembly secured at the correct width, line, and grade by welding the loop anchors and stud anchors to the reinforcing bars. The location of these welds shall be at least 100 mm below the top of the end dams and the spacing shall be at approximately 500 mm centres.

Abrasive blast cleaned areas shall have the concrete placed in the block-out within 48 hours of being cleaned or shall be reblasted. Abrasive blast cleaned concrete surfaces shall receive a bonding agent immediately prior to placing concrete. Concrete shall be placed and consolidated to minimize voids under the deck joint assembly and shall be hand finished with a wood float. All steel surfaces that are to be in contact with the preformed seal shall be protected during placing of concrete.

After concrete construction, the exposed faces of the structural steel shapes shall be cleaned to remove any concrete and deleterious material. The setting devices shall be flame cut at the gap between two to four hours after the concrete placement.

The setting device bolt holes for all nosing angles, as well as for the armouring angles of the joints shall be drilled to a depth of 20 mm, air blast cleaned, and immediately filled with epoxy.

After installation of the deck joint assemblies, the Contractor shall sawcut a 20 mm wide groove for the full depth of asphalt adjacent to each steel nosing angle. If the previously sawcut face is undamaged and within 5 mm of the specified location, the Contractor may elect to form the groove. The grooves shall be cleaned, dried, and filled with hot poured rubberized joint sealing compound according to OPSS 914.

When an expansion joint system is specified in the Contract Documents with an approved elastomeric concrete, the mixing, placing, and curing requirements of elastomeric concrete shall be according to the manufacturer's specifications.

920.07.01.05 Epoxy Injection

920.07.01.05.01 General

Epoxy shall be injected into the injection hose system once concrete in the expansion joint blockouts has been in place for a minimum of 7 Days and has a minimum compressive strength of 25 MPa.

The epoxy shall be kept at a temperature of 20 °C $\pm$ 5 °C prior to its use.

920.07.01.05.02 Injection Method

Only the supplier of the expansion joint system or his approved agent shall inject the epoxy used in the injection hose system.

Epoxy shall be mixed and pressure injected according to the manufacturer's specifications.

Injection shall start at the fitting at one end of a two-metre section of hose to initially fill the hose and continue until the epoxy emits at the other fitting of the same section. Injection shall then alternate at both fittings of the same section until the epoxy emits from the voids in the concrete or at the interface between the steel angles and concrete or both. The injection ports shall then be plugged.

The above procedure shall be repeated in each section of hose until the full length of the expansion joint system has been filled with epoxy. The top surface of the blockout shall be thoroughly cleaned to remove any excess epoxy prior to hardening.

After the epoxy has set, all adapters and injection plugs shall be removed and the plugholes filled with epoxy.

The deck joint assembly shall be checked for voids remaining under the angles. Holes shall be drilled in angles when voids are detected and voids and bolt holes shall be filled with epoxy.

920.07.01.05.03 Cold Weather Epoxy Injection Requirements

Epoxy injection shall not be performed in cold weather conditions without protection when the ambient air temperature is below 5 °C or is likely to fall below 5 °C within 48 hours immediately following the epoxy injection.

When the epoxy injection is to be performed under cold weather conditions, the temperature of the concrete in the expansion joint blockout shall be a minimum of 5 °C prior to the commencement of the injection. The temperature shall be maintained at a minimum of 5 °C for a period of 48 hours after injection or the curing time as specified in the manufacturer's data sheet.

920.07.02 Modification of Deck Joint Assemblies

920.07.02.01 General

The requirements of the Installation of Deck Joint Assemblies subsection apply to the Modification of Deck Joint Assemblies subsection.

Prior to installation of a new deck joint assembly and new reinforcing bars, the existing reinforcing steel, structural steel, and existing concrete against which new concrete is to be placed shall be abrasive blast cleaned according to OPSS 929.

When a new joint assembly is to be welded to existing hardware, the surface of the existing hardware that is to be in contact with the new joint assembly shall be abrasive blast cleaned according to OPSS 929.

920.07.02.02 Drilling and Preparation of Holes

The edge of drilled holes shall not be permitted within 50 mm of a concrete edge.

Holes for dowels or anchor bolts embedded in non-shrink grout shall be core drilled, flushed out with water, and air blast cleaned immediately after drilling. Immediately prior to placing non-shrink grout, the hole shall be predampened for one hour with no free water in the hole.

Holes for dowels or anchor bolts embedded in epoxy shall be impact drilled. The holes shall be cleaned of all deleterious material by air blasting and shall be dry when the epoxy is placed.

Mixing and placing procedures shall be according to the epoxy manufacturer's recommendations.

920.07.03 Repair of Existing Deck Joints

Repair of existing deck joint assemblies shall be according to the Installation of Deck Joint Assemblies and the Modification of Deck Joint Assemblies subsections and as specified in the Contract Documents.

920.07.04 Field Installation of Preformed Seals and Bolted Components

Preformed seals shall be installed in one continuous piece. Seals shall not be bent more than 30 degrees at any one location. The preformed seals and bolted components shall be installed according to the stamped deck joint assembly Working Drawings.

920.07.05 Placing Joint Fillers and Waterstops

Joint fillers and waterstops shall be firmly fixed in position before any concrete is placed so that their final position in the concrete remains as shown in the Contract Documents and are true to line and grade.

Field splicing of waterstops shall be by heat fusion.

920.07.06 Placing Joint Seals and Joint Sealing Compounds

920.07.06.01 Preparation of Joint

Concrete at all joints shall be sound; clean; dry; and free of all dust, debris, and deleterious material.

The joint face shall be true to line so that the joint seal shall bear on the joint face fully and uniformly.

920.07.06.02 Placing Joint Seals

Gaps forming longitudinal joints between structures shall be sealed with a joint seal made of ethyl vinyl acetate foam installed with the laminations horizontal.

Prior to installation of the joint seal, the joint recess shall be abrasive blast cleaned and air blasted according to OPSS 929 to remove laitance and deleterious material.

Adhesive shall be applied liberally to both vertical sides of the joint seal and to both vertical faces of the joint recess. Excess adhesive shall be removed immediately.

The joint seal shall be installed so that it remains below the level of the concrete surface when fully compressed.

The joint seals shall not be field spliced.

920.07.06.03 Placing Hot Poured Rubberized Asphalt Joint Sealing Compounds

Hot poured rubberized asphalt joint sealing compound shall be installed according to OPSS 914, except that the temperature of the air and the materials that are to be in contact with the sealing compound shall be 2 °C or greater at the time of installation.

920.07.07 Trial Installations

For designated trial installations, only deck joint assemblies pre-approved for trial installation by the Owner shall be used. The installation procedures shall be according to the manufacturer's detailed instructions, the Contract Documents, and applicable parts of this specification.

920.07.08 Quality Control

920.07.08.01 Water Test

The air, concrete, and deck joint assembly temperature shall be 2 °C or higher at time of testing.

After the epoxy has set and prior to acceptance, the joint shall be water tested over its entire length when there are no upturns. When there are upturns, the joint shall be tested between the gutter lines. The water shall be continuously ponded for a minimum of one hour, maintaining a minimum depth of 25 mm along the tested length and a minimum depth of 100 mm above the deck joint assembly at the gutter lines. For superelevated decks, only the lower gutter line requires the testing at a depth of 100 mm. The width shall extend 50 mm beyond the concrete dams on both sides of the deck joint assembly. When the staging of traffic is required, the joint shall be tested in overlapping sections.

Leakage of water through the deck joint assembly during this test, including the interface between the preformed seal and the seal retainers, concrete to steel interfaces, and the concrete construction joints, shall constitute failure of the deck joint assembly.

If such failure occurs, the deck joint assembly shall be repaired or replaced and the water test repeated. The method of repair shall be submitted in writing to the Contract Administrator for review prior to commencement of repair work.

Leakage at an elastomeric concrete to steel interface and at an elastomeric concrete to concrete interface, shall require replacement of the elastomeric concrete joint system and the water test repeated.

The water test and any related corrective work shall be completed prior to any seasonal shutdowns. When this is not feasible, a proposal detailing an alternative solution shall be submitted to the Contractor Administrator for approval.

920.07.09 Corrective Work for Initial Acceptance

At the Contractor’s expense, all defects identified in the Criteria for Initial Acceptance of the Deck Joint Assembly subsection shall be repaired according to the requirements of this specification and to the satisfaction of the Contract Administrator.

920.07.10 Performance Warranty

920.07.10.01 General

The Contractor shall warrant that the deck joint assemblies have been fabricated and installed according to the specifications and shall be free from deficiency for a period of 2 years from the date of the issuance of the Certificate of Substantial Performance.

The warranty shall expire when both of the following occur:

a) The two-year warranty period has elapsed.

b) There are no deficiencies or all deficiencies have been corrected to the satisfaction of the Owner.

When time is required beyond the 2 years for the Contractor to correct any defects, the warranty shall continue until repair or replacement has been completed to the satisfaction of the Owner.

920.07.10.02 Warranty Evaluation

Two months prior to the expiry of the two-year warranty, the Owner shall evaluate the deck joint assembly according to the requirements of the Criteria for Final Acceptance of Deck Joint Assemblies clause. The Owner shall notify the Contractor of the time and date of the inspection. The Contractor shall be present during this inspection.

The Owner shall notify the Contractor of all defects that require corrective work according to the Criteria for Final Acceptance of Deck Joint Assemblies clause.

When there are deficiencies, the deck joint assembly and its installation shall not be accepted until appropriate corrective work has taken place to the satisfaction of the Owner.

920.07.10.03 Final Acceptance

Two weeks prior to the commencement of corrective work of the deck joint assembly, a description of the method to be used for corrective work shall be submitted to the Owner for review and approval. The submission shall be accompanied by a report indicating the cause of each defect.

The Contractor shall repair all defects according to the requirements of this specification and the approved proposal to the satisfaction of the Owner. If the deck joint assembly has to be replaced, its successor shall be an equivalent approved joint. All costs including labour, Equipment, Material, and traffic control shall be at the expense of the Contractor.

All corrective work shall be done within three months of the inspection, unless prevented by seasonal shutdown, in which case, the work shall be done during the first 5 weeks of the following construction season. The Contractor shall provide a minimum of three days notice to the Owner prior to carrying out any corrective work.

920.07.11 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

920.08 QUALITY ASSURANCE

920.08.01 Sampling and Testing

Random sampling and testing shall be performed.

920.08.02 Preformed Seal Sample

A sample shall be taken from the extra length of preformed seal supplied for each joint delivered to the Working Area for testing according to Table 1 in OPSS 1210.

920.08.03 Criteria for Initial Acceptance of Deck Joint Assembly

On completion of the deck joint assembly installation, the Contract Administrator shall inspect for the following deficiencies:

a) Defective seals.

b) Cracks wider than 0.3 mm and voids in concrete end dams.

c) Defective coating.

d) Seal not completely held in retainer.

e) Bolt torque not as specified on the stamped deck joint assembly Working Drawing.

f) Defective, loose, or missing structural components and welds.

g) Leakage at interfaces determined according to the Water Test clause.

h) A line parallel to the centreline of the structure joining the tops of all steel components of the deck joint assembly that deviates from a line parallel to the pavement profile between nosing angles by more than 3 mm, at any location along the length of the expansion joint.

i) For modular joints, at any location along the length of the deck joint assembly, the relative difference in the opening between the steel retainers exceeds the narrowest width by 6 mm. This dimension shall be measured at the level of the road surface, perpendicular to the centreline of the expansion joint, and at the inner faces of the retainers.

j) Any portion of the deck joint assembly is extending above the finished road surface.

920.08.04 Criteria for Final Acceptance of Deck Joint Assemblies

The deck joint assembly shall be inspected by the Owner and shall be accepted, provided the deficiencies listed below do not exist:

a) Defective seals as a result of material deficiencies.

b) Defective coating of components as a result of coating application or material deficiencies.

c) Seal not completely held in retainer.

d) Loose bolts.

e) Defective, loose, or missing structural components and welds.

f) Delaminated or spalled concrete or both.

920.10 BASIS OF PAYMENT

920.10.01 Deck Joint Assemblies, Installation - Item
Deck Joint Assemblies, Modification - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

920.10.02 Repair of Existing Deck Joints - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

When the repairs are not specified in the Contract Documents, payment for the cost of repairing existing deck joints and of repairing concrete prior to the installation of deck joint assemblies or preformed seals shall be administered as Extra Work.

920.10.03 Preformed Seals, Joint Fillers, Joint Seals, Joint Sealing Compounds, and Waterstops

Payment for the tender items in which preformed seals, joint fillers, joint seals, joint sealing compounds, and waterstops are placed shall include full compensation for all labour, Equipment, and Material to do the work of placing these materials.

Appendix 920-A, November 2012
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The following shall be specified in the Contract Documents:

- Deck joint assembly working drawing and bolt tension. (920.04.01.02.01)

- Modification of deck joint assembly. (920.04.01.02.01.01)

- Placement of deck joint assembly. (920.07.01.04)

- Repair of existing deck joint assemblies. (920.07.03)

- Location, line, and grade for installing preformed seals and bolted components. (920.07.05)

- Trial installations of deck joint assemblies. (920.07.07)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 3950.100 Joints, Concrete Expansion and Construction, On Structure

ONTARIO PROVINCIAL STANDARD SPECIFICATION

METRIC
OPSS.MUNI 922
APRIL 2017
(Formerly OPSS 922, November 2009)

Note: The MUNI implemented in April 2017 replaces OPSS 922 COMMON, November 2009 with no technical content changes.

CONSTRUCTION SPECIFICATION FOR INSTALLATION OF BEARINGS

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922.01 SCOPE

This specification covers the construction requirements for the installation of bearings.

922.01.01 Specification Significance and Use

This specification has been developed for use in municipal oriented Contracts. The administration, testing, and payment policies, procedures, and practices reflected in this specification correspond to those used by many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

922.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

922.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Material

OPSS 1202 Bearings - Elastomeric Plain and Steel Laminated
OPSS 1203 Bearings - Rotational and Sliding Surface

CSA Standards

A23.1-04/A23.2-04 Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete

ASTM International

C 928-05 Standard Specification for Packaged, Dry, Rapid-Hardening Cementitious Materials for Concrete Repairs

922.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Anchor means a device employed to secure a bearing to the structure or to restrict movement of the structure or both.

Bearing means a structural device that transmits load while permitting translation or rotation or both.

Certificate of Conformance means a document issued by the Quality Verification Engineer confirming that the specified components of the Work are in general conformance with the requirements of the Contract Documents.

Engineer means a Professional Engineer licensed by the Professional Engineers Ontario to practice in the province of Ontario.

Product Drawings means drawings prepared by the manufacturer that have been approved by the Owner for use with the product.

Quality Verification Engineer (QVE) means an Engineer retained by the Contractor qualified to provide the services specified in the Contract Documents.

Superstructure means all parts of a bridge above the bearings.

922.04 DESIGN AND SUBMISSION REQUIREMENTS

922.04.01 Submission Requirements

922.04.01.01 Layout and Installation Drawings

922.04.01.01.01 General

The Contractor shall submit 3 sets of bearing layout and installation drawings to the Contract Administrator at least 1 week prior to commencement of bearing installation, for information purposes only. An Engineer's seal and signature shall be affixed on the layout and installation drawings verifying that the drawings are consistent with the Contract Documents.

The Contractor shall have a copy of these drawings at the site prior to and during site installation of the bearings.

922.04.01.01.02 Elastomeric Bearings

The layout and installation drawings for elastomeric bearings shall clearly indicate the following:

a) Bearing layout and orientation.

b) Dimensions and details of the bearings.

c) Details of the top or bottom plate, or both, including anchorages or dowels or both.

d) Installation details.

e) Load resistance at serviceability and ultimate limit states, including maximum compressive permanent and total loads.

f) Individual alphanumeric identification of each bearing.

922.04.01.01.03 Rotational and Sliding Surface Bearings

The layout and installation drawings for rotational and sliding surface bearings shall clearly indicate the following:

a) Bearing layout and orientation.

b) Top and bottom plate details, including anchorages.

c) Installation details.

d) Method of attachment of bearings to the top and bottom plates.

e) Bearing identification letter and numbers.

922.04.01.02 Jacking

When jacking of the superstructure is specified in the Contract Documents, the Contractor shall submit 3 sets of the jacking drawings to the Contract Administrator at least 1 week prior to commencement of jacking, for information purposes only. The submission shall include the method and location, type, and capacity of jacks to be used; the type and location of the gauges; and the calibration certificates for both the jacks and gauges. An Engineer shall affix his or her seal and signature on the jacking drawings verifying that the drawings are consistent with the Contract Documents and sound engineering practices.

When jacking is not specified in the Contract Documents, the Contractor shall submit 5 sets of the jacking proposal drawings to the Contract Administrator at least 3 weeks prior to the commencement of jacking, for approval. The submission shall include the method and location, type, and capacity of jacks to be used; the type and location of the gauges; and the calibration certificates for both the jacks and gauges and, where necessary, the details of support for the jacks. Proposals shall bear the seals and signatures of the design and checking Engineers.

A copy of each jacking proposal drawing shall be returned as one of the following:

a) Stamped with the wording that allows for permission to construct. In this case, work can commence on receipt of the drawing by the Contractor.

b) Stamped with the wording that allows for permission to construct as noted. In this case, work can start on receipt of the drawings by the Contractor. The drawings shall be updated as noted and shall be sealed and signed by an Engineer stating the drawings have been revised according to the noted comments.

c) Showing only required changes. In this case, the drawings shall be updated as required and the submission process repeated.

When another authority is involved with the Contract, all submissions shall be made at least 5 weeks prior to the commencement of work.

The Contractor shall have a copy of the jacking drawings or the approved jacking proposal drawings at the site prior to and during the jacking operation.

922.05 MATERIALS

922.05.01 Bearings

Bearings shall be according to OPSS 1202 or OPSS 1203 and as specified in the Contract Documents.

922.05.02 Grout

Grout shall be cement based, non-shrink, non-staining, and approved by the Owner.

Grout shall have a minimum nominal 7-Day compressive strength of 35 MPa.

922.07 CONSTRUCTION

922.07.01 General

The bearings shall be protected from damage, distortion, excessive heat, and deleterious matter during the handling, transportation, storage, and installation.

The bearings shall not be disassembled by the Contractor without the permission of the bearing supplier. The bearing supplier's representative shall be present during disassembly and reassembly.

Upon completion of the structure, the top and bottom surfaces of the bearings shall be in full contact with the structure.

Grouting operations shall be according to the manufacturer's recommendations, except that the temperature of the air, concrete, and bearings shall not be less than 10 °C at the time of grouting and shall be maintained at not less than 10 °C for a minimum of 96 hours after grout is placed.

922.07.02 Bearing Seats

The bearing seats shall be finished level and to an elevation established by subtracting the thickness of the bearings supplied from the top of bearing elevations specified in the Contract Documents. For elastomeric bearings, the finish of the concrete surface shall be smooth and not vary more than 1 mm along a straightedge placed in any direction across an area that extends at least 25 mm beyond the outside limits of the bearing. For other types of bearings, deviation along the straightedge shall not vary more than 3 mm.

Any concrete surface area prepared by grinding shall not allow water to pond in the area. For elastomeric bearings, the bearing seat areas prepared by grinding shall be intentionally roughened such that the surface has an equivalent to trowel finish. All surface areas shall be inspected and deemed acceptable by the Contract Administrator prior to installation of bearings.

922.07.03 Alignment

The longitudinal and transverse centrelines of the bearings shall be installed within $\pm$ 3 mm of the position specified in the Contract Documents. The centreline of the bearing along the direction of movement shall be parallel to the direction of movement of the bridge at that bearing location.

922.07.04 Installation of Anchors

The diameter, length, and material of the anchor and the diameter and depth of the anchor hole shall be as specified in the Contract Documents.

Where coring of the bearing seats to receive anchors is permitted, care shall be taken to ensure that the coring is done without damaging or cutting the steel reinforcement. Where permitted, coring shall not commence earlier than 3 weeks prior to bearing installation. In lieu of coring, the holes may be formed.

The holes shall be protected against entry of moisture and shall be completely filled with grout, when the anchors are installed.

922.07.05 Grouting

Where the anchors for rotational and sliding surface bearings require core drilling or preformed holes, the bearings shall be bedded over their entire area on grout that does not contain any voids. The use of permanent shims to achieve the theoretical elevation at the top of the bearing shall not be allowed.

The thickness of the grout bedding for rotational and sliding surface bearings shall be 12 mm $\pm$ 3 mm. The substrate shall be roughened by bushhammering, cleaned, and prewetted prior to grouting. Transfer of superstructure load to the bearings shall not be allowed until the grout has reached a minimum strength of 30 MPa.

The grout material shall be mixed, handled, and cured according to the manufacturer's instructions.

Elastomeric bearings shall not be placed directly on grout.

922.07.06 Tolerances

Bearings shall be set level to within a 500H:1V slope in any direction. The top of the bearing shall be set at the theoretical elevation specified in the Contract Documents, within the following tolerances:

Concrete deck and precast I-type girders	$\pm$ 5 mm
Steel plate girders	0 to + 3.0 mm
Steel and precast concrete box girders	0 to + 2.0 mm

922.07.07 Temporary Attachments

Temporary clamping devices shall be used to maintain correct orientation and setting and to prevent movement or separation of the bearing components during the handling, transportation, and installation. The clamping devices shall not be used for lifting or suspending the bearings. Clamping devices shall be removed after each bearing is in its final position, with all permanent connections made, and after all grout and concrete in contact with the bearing have been placed.

922.07.08 Jacking

Jacking operations shall be carried out under the direct supervision of an Engineer.

The lifting or lowering of the structure shall be carried out in one uniform and synchronized jacking operation. At no time during jacking operations shall the difference between any of the jacking points be more than 3 mm at the same abutment or pier cap.

When jacking is required in order to adjust the bearings, the structure shall be jacked the minimum amount required to allow the bearings to come back to a vertical position.

922.07.09 Quality Control

922.07.09.01 Certificate of Conformance

A completed Certificate of Conformance shall be submitted to the Contract Administrator upon completion of the work. The Qualification Verification Engineer's seal and signature shall be affixed on the completed Certificate of Conformance confirming that the following are in general conformance with the requirements of the layout and installation drawings, Working Drawings, product drawings, and Contract Documents for the bearings:

a) Fabrication

b) Installation

c) Adjustments, when applicable

922.07.09.02 Sampling and Supplying of Bearings

After the bearings have been fabricated, the Contractor shall notify the Contract Administrator in writing of the identification and availability of the bearings.

Where strip bearings have been specified for precast boxes placed side-by-side, each bearing strip shall be supplied at least 600 mm longer than required. A sample, 600 mm in length, shall be cut in the field from one end of each strip bearing and supplied for testing.

Elastomeric bearings beyond the number of bearings specified for installation shall be supplied as specified in the Contract Documents.

All bearings shall be available for sampling either at the project site or at a location acceptable to the Contract Administrator. Sample bearings for testing purposes shall be selected by the Contract Administrator from all the bearings of each size and thickness fabricated for the Contract. The Contract Administrator shall advise the Contractor in writing which bearings have been selected for testing. The Contractor shall deliver these bearings to the location specified in the Contract Documents.

922.07.09.03 Grout Testing

Three 7-Day compressive strength cubes shall be made and tested according to ASTM C 928 for each day that grout is being placed.

For early strength testing, additional cubes shall be tested.

922.08 QUALITY ASSURANCE

922.08.01 Testing

The Contractor shall allow 60 Days from the time of submission of elastomeric bearings for the Owner's testing program.

The number, type, and size of elastomeric bearing samples to be selected for destructive testing shall be as specified in the Contract Documents.

922.08.02 Rejection

If a sample plain elastomeric bearing fails, all plain elastomeric bearings represented by that sample shall be rejected.

If the number of laminated elastomeric bearings specified is less than 10, failure of the sample bearing shall mean that all laminated elastomeric bearings are rejected.

If the number of laminated elastomeric bearings specified is 10 or more, failure of a sample bearing shall mean that all laminated elastomeric bearings of that size and thickness are rejected.

Rejected bearings, whether installed or not, shall be removed from the job site. Bearings supplied as replacements for rejected bearings shall be sampled, tested, and approved or rejected on the same basis as the original bearings.

922.09 MEASUREMENT FOR PAYMENT

922.09.01 Bearings

For measurement purposes, a count shall be made of the number of the bearings installed and of the bearings supplied for destructive testing. Alternatively, bearings may be a lump sum item.

922.10 BASIS OF PAYMENT

922.10.01 Bearings - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the Work.

When bearings are a lump sum item, payment at the Contract price for the tender item Bearings shall include full compensation for the bearings supplied for destructive testing.

Appendix 922-A, November 2009
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- When jacking of a structure is required. (922.04.01.02)

- Type of bearing. (922.05.01)

- Top of bearing elevation. (922.07.02)

- Bearing location. (922.07.03)

- Bearing anchor dimensions and material. (922.07.04)

- Bearing anchor hole dimensions. (922.07.04)

- Number of sample bearings and delivery location of samples for testing. (922.07.09.02)

- Number, type, and size of elastomeric bearings for destructive testing. (922.08.01)

OPSS 922 contains information that is not used by municipalities in their Contracts. To ensure completeness of the municipal Contract Documents, the designer should invoke Appendix 922-B. The appendix contains information that modifies OPSS 922 so it can be used by a municipality in its Contracts.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

Appendix 922-B, November 2009
FOR USE IN MUNICIPAL CONTRACTS, WHEN REFERENCED IN THE CONTRACT DOCUMENTS

Note: This is a non-mandatory Additional Information Appendix intended to provide supplementary requirements for the OPS specification in a municipal contract, when the appendix is invoked by the Owner. It is written in mandatory language to permit invoking it by reference in the Contract Documents. If the appendix has not been invoked by reference in the Contract Documents, it does not apply.

Supplementary Requirements for Using OPSS 922 in Municipal Contracts

OPSS 922, Installation of Bearings, is amended as follows:

922.03 DEFINITIONS

Section 922.03 is amended by the deletion of the definitions for Certificate of Conformance and Quality Verification Engineer.

922.04.01.01.01 General

Clause 922.04.01.01.01 is deleted in its entirety and replaced by the following:

The Contractor shall submit 5 sets of bearing layout and installation drawings to the Contract Administrator at least 3 weeks prior to commencement of bearing installation, for information purposes only. An Engineer shall affix his or her seal and signature on the layout and installation drawings verifying that the drawings are consistent with the Contract Documents and sound engineering practices.

The Contractor shall have a copy of these drawings at the site prior to and during site installation of the bearings.

922.04.01.02 Jacking

Clause 922.04.01.02 is deleted in its entirety and replaced by the following:

When jacking of the superstructure is specified in the Contract Documents or is required due to the Contractor's method of construction, the Contractor shall submit 5 sets of the jacking or jacking proposal drawings to the Contract Administrator at least 3 weeks prior to the commencement of jacking, for review. The submission shall include the method and location, type, and capacity of jacks to be used; the type and location of the gauges; and the calibration certificates for both the jacks and gauges and, where necessary, the details of support for the jacks.

All jacking drawings shall bear the seal and signature of an Engineer verifying that the drawings are consistent with the Contract Documents and sound engineering practices.

Proposals shall bear the seals and signatures of the design and checking Engineers.

Appendix 922-B

922.04.01 Design and Submission Requirements

Subsection 922.04.01 is amended by the addition of the following:

922.04.01.03 Return of Submissions

Two copies of each submission shall be returned as one of the following:

a) Stamped with the wording that allows for permission to construct. In this case, work can commence on receipt of the drawings by the Contractor.

b) Stamped with the wording that allows for permission to construct as noted. In this case, work can start on receipt of the drawings by the Contractor. The drawings shall be updated as noted and shall be sealed and signed by an Engineer stating the drawings have been revised according to the noted comments.

c) Showing only required changes. In this case, the drawings shall be updated as required and the submission process repeated.

When another authority is involved with the Contract, all submissions shall be made at least 5 weeks prior to the commencement of work.

The Contractor shall have a copy of the stamped updated or accepted drawings at the site during any jacking operation.

922.07.09.01 Certificate of Conformance

Clause 922.07.09.01 is deleted in its entirety.

CONSTRUCTION SPECIFICATION FOR STRUCTURE REHABILITATION-CONCRETE REMOVAL

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928-A **Commentary**

928.01 SCOPE

This specification covers the requirements for the removal of concrete from existing structures, except by means of pressurized water, hydrodemolition, in order to facilitate structure rehabilitation.

928.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

928.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

928.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 905 Steel Reinforcement for Concrete

CSA Standards

CSA S6-14 Canadian Highway Bridge Design Code

928.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Concrete Crusher means a piece of equipment fitted with a hydraulic attachment, such as a scissor type jaw, used for the removal of concrete.

Concrete Removal - Full Depth means concrete removals that typically apply to full or partial length removals of entire thickness of curbs, sidewalks, medians, wingwalls, concrete barrier walls and parapet walls, ballast walls, and approach slabs. This also applies to localized removals extending the full thickness of slab decks and culverts.

Concrete Removal - Partial Depth, Type A means concrete removals that typically apply to the top surface of decks, including removals over round voids in post tensioned structures; sidewalks; curbs; and culvert and tunnel floor slabs and the top and inside faces of concrete barrier and parapet walls.

Concrete Removal - Partial Depth, Type B means concrete removals that typically apply to deck soffit and fascia of bridge decks, soffit of the top slab of culverts and tunnels, girders, diaphragms, and outside face of concrete barrier walls and parapet walls.

Concrete Removal - Partial Depth, Type C means concrete removals other than the ones specified for Concrete Removal - Partial Depth, Type A and Type B, and typically apply to abutments, wingwalls, pier columns and caps, bearing seats, retaining walls, and vertical walls of culverts and tunnels.

Concrete Removal Sequence means a specified order of concrete removals within a stage to ensure structural adequacy, stability, and integrity throughout construction.

Concrete Removal - Structural Component means concrete removals that typically apply to full or partial length removals of entire thickness of decks, girders, diaphragms, pier columns, and pier caps that have an impact on the structural adequacy, stability, and integrity of a structure.

Ergonomic Positioning Device means a piece of equipment used for affixing or suspending hand-held air breakers for the purpose of minimising worker fatigue.

Layer - Reinforcing means two or more reinforcing bars placed in a plane parallel to a concrete face.

Mat - Reinforcing means two layers of reinforcing bars, in different directions, tied together.

Rehabilitation means any modification, alteration, or improvement to a structure or its components that is designed to correct defects or deficiencies.

Reinforcing means deformed steel bars or GFRP bars used in the reinforcing of concrete and includes splice bars.

Rig-mounted Breaker means a piece of equipment fitted with a hydraulic or pneumatic attachment, such as a breaker, used for the removal of concrete. Pneumatically driven hand-held air breakers affixed to or suspended from an Ergonomic Positioning Device shall not be considered a rig-mounted breaker.

Scarifying means the removal of concrete from the top surface of a structure, to a specified depth achieved by the milling action of cutting teeth fitted to a rotating head.

Reinforcement means a general term that includes reinforcing steel bars, splice bars, welded steel wire fabric, and prestressing tendons, and/or GFRP reinforcement.

Structure means any bridge, culvert, tunnel, retaining wall, wharf, dock, guideway, or any part thereof or other reinforced concrete component designed to carry loads, including high mast pole footings and sign support footings.

928.04 DESIGN AND SUBMISSION REQUIREMENTS

928.04.01 General

The Contractor shall meet all design and submission requirements from other authorities, as specified in the Contract Documents. The requirements of these authorities and the Owner shall be satisfied before commencement of concrete removals.

928.04.02 Design Requirements

The structural design and evaluation shall be carried out according to CSA S6.

The design assumptions for structural design and evaluation shall accurately represent the condition of the structure during construction, including the effect of concrete removals on load distribution and member resistance, support location and restraints, construction loads and construction staging, and shall be based on the existing structure drawings, as verified in the field.

The weights of construction equipment shall be based on the manufacturer's specifications. The minimum dynamic load allowance for rig-mounted breakers and concrete crushers shall be 0.4. The load factors for construction live loads shall be the same as for highway live loads.

928.04.03 Submission Requirements

928.04.03.01 Access to Work Areas, Platforms, and Scaffolding

When access to work areas, work platforms, and scaffolding are to be provided, the Contractor shall submit to the Contract Administrator detailed drawings, for information purposes, prior to the installation.

928.04.03.02 Working Drawings

The Contractor shall submit 3 sets of Working Drawings to the Contract Administrator at least 7 Days prior to the commencement of the concrete removals, for concrete removal, complete deck and concrete removal, structural component, for information purposes only. The Contractor shall have a copy of the Working Drawings on site at all times while the work is being carried out.

All Working Drawings shall contain the following:

a) Layout and description of concrete removal sequences and temporary supports.

b) Clearances at existing and proposed structures.

c) The locations, loadings, and detailed descriptions of heavy equipment and vehicles to be supported on existing structures.

d) Seal and signature of the design Engineer and design-checking Engineer employed or retained by the Contractor, and a statement certifying that based on the existing drawings of the structure, as verified in the field, that the serviceability limit state and ultimate limit state requirements of CSA S6 are satisfied when any one or more of the following are proposed by the Contractor:

    i. Existing structures supporting rig-mounted breakers, concrete crushers, cranes, any other heavy equipment, and vehicles that would induce higher load effects than normal traffic on a structure.
    ii. Removal sequence different from the one specified in the Contract Documents or when the Contract Documents do not specify a removal sequence.

e) Identify stages of work that require interim inspection by the Contractor's Engineer for the safe execution of concrete removal, such as:

    i. Installation of temporary support.
    ii. Installation of temporary protection for traffic, pedestrians, and property.
    iii. Structural strengthening or modification.
    iv. Removal of existing dead load or earth pressure, or both.

928.04.03.03 Concrete Removal Equipment

The Contractor shall submit identification of equipment and the manufacturer's published specifications for all concrete removal equipment to be used to the Contract Administrator, at least 7 Days prior to the commencement of the concrete removal operation.

928.04.03.04 Saw Cutting Details

When it is intended to cut full thickness through a concrete component by the use of sawing equipment, the Contractor shall submit saw cutting details to the Contract Administrator, at least 7 Days prior to the intended commencement of the saw cutting operation. The details shall include the following:

a) Depth and location of sawcuts.

b) Method used to prevent any contact with components that are to remain in place.

c) Method of collecting and managing the effluent from the saw cutting operation.

928.04.03.05 Traffic and Pedestrian Protection

Unless otherwise specified in the Contract Documents, the Contractor shall submit a description of the traffic and pedestrian protection plan to the Contract Administrator, at least 7 Days prior to the commencement of the concrete removal operations.

928.06 EQUIPMENT

928.06.01 Air Hammers

Air hammers shall be hand-held and meet the following requirements:

a) Chipping hammers shall have a maximum weight of 9.0 kg prior to any handle modification and a maximum piston stroke of 102 mm.

b) Jack hammers shall have a maximum weight of 14.0 kg.

c) All hammers shall have the manufacturer's name and part or model number engraved on them by the manufacturer. All information must be clearly legible.

The manufacturer's published specifications shall be the sole basis for determining weight and piston stroke.

928.06.02 Rig-Mounted Breakers

Rig-mounted breakers using pneumatically driven equipment shall only be fitted with a moil point and produce a maximum energy of 1,000 Joules per blow as per manufacturer's specification.

928.06.03 Sawing Equipment

The sawing equipment shall be capable of sawing the concrete along the lines and to the depths specified in the Contract Documents.

928.06.04 Scarifiers

Equipment used for scarifying shall be capable of removing a minimum of 6 mm of concrete from the top surface of the structure in one pass.

The maximum weight of a scarifier used on bridge decks shall not exceed 26 tonnes.

928.06.05 Straight Edges

Two commercially made metal straight edges, 1.5 m and 3 m in length, shall be supplied so as to provide datum line for depth of removals.

928.07 CONSTRUCTION

928.07.01 General

Concrete shall be removed to the depth and demarcated boundaries as specified in the Contract Documents or as directed by the Contract Administrator.

Upon completion of the concrete removals in the demarcated areas, the Contractor shall notify the Contract Administrator for inspection of the removal areas. Additional areas of concrete removal identified by the Contract Administrator shall be removed as directed by the Contract Administrator.

928.07.02 Access to Work Area, Work Platform, and Scaffolding

Adequate access shall be provided to the work area, work platform, and scaffolding as required, for the following:

a) Concrete surveys by the Contract Administrator.

b) Inspection of work and measurement of the quantities by the Contract Administrator.

c) Quality Assurance and acceptance inspections by the Owner.

d) Performance of the Contractor's work, including concrete removals.

928.07.03 Concrete Surveys

928.07.03.01 General

The Contractor shall schedule operations so as to ensure there is no interference with the concrete surveys.

928.07.03.02 Covermeter Survey

The Contractor shall allow the Contract Administrator to carry out a bridge deck covermeter survey for all asphalt-covered decks when concrete removals from the top surface of the deck are specified in the Contract Documents.

The Contractor shall notify the Contract Administrator 24 hours prior to the commencement of the scarifying operation.

The covermeter survey shall be carried out as follows:

a) When the deck is specified to be patched, complete the survey after the waterproofing is completely removed from the top surface of the deck.

b) When an overlay is specified in the Contract Documents, complete the survey after the first pass of the scarifying equipment.

928.07.03.03 Concrete Removal Surveys

928.07.03.03.01 General

The Contractor shall submit a written notification to the Contract Administrator to carry out all applicable concrete removal surveys. The notification shall state that the Contractor has completed the work specified in the Work Requirements clause for the concrete removal surveys specified and has installed all accesses to the work area, including work platforms and scaffolding required by the Contract Administrator to carry out the surveys.

When the location and extent of removals are not completely defined in the Contract Documents, the Contract Administrator shall carry out one or both of the following concrete removal surveys as part of determining and demarcating the actual location and extent of removals:

a) Visual and Delamination Survey

   A visual and delamination survey shall be carried out for all concrete removals.

   When a structure has an existing overlay that is not to be completely removed, the Contract Administrator shall carry out the delamination survey twice. The first survey shall be carried out on the top surface of the entire overlay. The second survey shall be carried out on the top surface of the original deck within the removal area, after the existing overlay has been removed.

   When a structure has an existing overlay that is to be completely removed, the Contract Administrator shall carry out the delamination survey after the overlay is completely removed.

b) Corrosion Potential Survey (Half-Cell)

   A corrosion potential survey shall be carried out on all surfaces when concrete is to be removed based on corrosion potential criteria when specified in the Contract Documents.

When full depth removals are specified in the Contract Documents, the concrete removal surveys on the top of the deck and soffit shall be completed to determine and demarcate the full depth concrete removal areas.

Concrete removals shall not proceed until all the applicable concrete surveys have been completed, reviewed, and written permission to proceed has been given by the Contract Administrator.

928.07.03.03.02 Work Requirements

Prior to the concrete removal surveys, the Contractor shall carry out all applicable work as follows:

a) Scarifying **-** Complete the scarifying operations.

b) Refacing with Uniform Concrete Removal - Complete the uniform removal of concrete.

c) Removal of Waterproofing, Asphalt, and Coatings - All existing waterproofing membrane, asphalt, and coatings shall be removed in such a way to prevent damage to the existing concrete surface.

d) Concrete Removal by Corrosion Potential - The Contract Administrator shall select two widely separated locations for each portion of the structure when the reinforcing steel is continuous. The reinforcing steel within these locations shall be exposed for a length of 150 mm and a clearance of 25 mm all around the bar.

Immediately prior to the commencement of the concrete removal surveys, all equipment shall be removed and all debris and standing water cleared from the surfaces to be surveyed.

928.07.03.03.03 Time Requirements

The time required by the Contract Administrator to complete the concrete removal surveys, including review of the surveys by the Owner, shall be as specified in Table 1 and shall commence upon receipt of the Contractor's written notification to carry out the concrete removal surveys. When the area of a structure exceeds the maximum area surveyed for the time period shown, the time period specified in Table 1 shall be extended on the basis of prorating the area, rounded up to the nearest Business Day.

For corrosion potential surveys, the maximum time period required to complete the survey does not include any days of inclement weather or days when the air temperature is below 5 °C.

928.07.04 Scarifying

928.07.04.01 General

The portion of the structure to be scarified and the depth of scarifying shall be according to the Contract Documents.

Prior to scarifying, all sand and debris shall be removed from the top surface of the structure to be scarified. The maximum depth of scarifying in any one pass of the scarifying equipment shall be 10 mm. After the scarifying operation, areas of the structure not scarified to the specified depth shall be re-scarified until the specified depth is achieved.

When the specified depth of scarifying is greater than 10 mm, the Contractor shall allow the Contract Administrator a 24-hour period to complete the covermeter survey prior to commencing the second pass of the scarifying.

The portion of the curb face, barrier or parapet wall, and all existing concrete surfaces that have not been scarified against which new concrete is to be placed shall be uniformly roughened by means of scabbling, chipping hammer, or bushhammering. A surface profile of 5 mm $\pm$ 2 mm shall be achieved by exposing the aggregates across the entire surface.

All material resulting from the scarifying operation shall be removed from the deck immediately after each pass of the scarifying equipment.

928.07.04.02 Protection of Reinforcing Steel

The Contractor shall immediately notify the Contract Administrator of any exposed reinforcing steel visible on the concrete surface prior to and at any time during the scarifying operation. Operations shall be adjusted to avoid contacting the reinforcing steel with the scarifying equipment.

The Contract Administrator shall demarcate an area around any exposed reinforcing steel. The concrete shall be removed from within the demarcated area to the depth specified for the adjacent scarifying area using chipping hammers or as directed by the Contract Administrator.

Exposed reinforcing steel shall not be cut, removed, or damaged.

928.07.05 Reinforcing Steel in Concrete Removal Areas

When the cutting, bending, and removal of reinforcing steel is specified in the Contract Documents, the work shall be done as part of concrete removals. The cutting and bending of reinforcing steel shall be according to OPSS 905.

When the area of concrete removal with exposed reinforcing steel exceeds 2 m^2, the reinforcing steel shall be retied at every second intersection point and shall be supported to maintain the steel mat in its original location. Supports shall be placed as required and tied securely to the reinforcing steel according to OPSS 905.

928.07.06 Equipment Restrictions

928.07.06.01 General

Only equipment specified shall be permitted for the removal of concrete.

Construction equipment shall be permitted on the structure provided that all of the following conditions are met:

a) Contamination by oil or other deleterious substances shall be prevented. Contaminated concrete shall be removed according to the procedures specified in the Concrete Removal - Partial Depth Type A, B, and C clause.

b) Vehicles, runways, and equipment other than hand held equipment shall not be supported by reinforcing steel.

c) Heavy vehicles such as ready mix concrete trucks or dump trucks shall not be permitted on any portion of the deck, within a span, once concrete removals within the deck have commenced in that span.

928.07.06.02 Concrete Removal - Partial Depth Types A, B, and C

Only chipping hammers shall be used for all partial depth concrete removals.

928.07.06.03 Concrete Removal - Complete Deck, Deck Joint Assemblies, Full Depth, and Structural Component

928.07.06.03.01 Sawing Equipment

The use of sawing equipment, except for perimeter treatments of concrete removal areas shall not be permitted for the removal of concrete:

a) Within the lap length of reinforcing steel to remain in place.

b) Within 100 mm from the edges and faces of structural steel members and concrete components to remain in place.

Prior to making sawcuts in a concrete deck close to the areas of existing structural steel members and other components that are to remain, the concrete surface shall be delineated by a qualified surveyor to locate the underlying edges and the faces of structural steel members and other components so not to damage the structural steel members and other components while saw cutting the concrete as specified.

928.07.06.03.02 Chipping Hammers

The use of chipping hammers shall be permitted in all areas of concrete removal.

928.07.06.03.03 Jack Hammers

The use of jack hammers shall not be permitted for the removal of concrete:

a) For partial depth removals.

b) Within 100 mm from concrete to remain in place.

c) Within 25 mm of any reinforcing steel to remain in place.

d) Within 100 mm from the edges and faces of structural steel members to remain in place.

928.07.06.03.04 Rig-Mounted Breakers

The use of rig-mounted breakers shall not be permitted for the removal of concrete:

a) In concrete barrier and parapet walls, and deck slabs supported by concrete girders, unless the girders are to be removed.

b) In concrete barrier and parapet walls supported by steel beams, unless the deck slab is to be removed.

c) Within the deck joint assembly.

d) Located within a distance from concrete to remain in place equal to the sum of 600 mm and the specified lap length of reinforcing steel to remain in place.

e) Within 600 mm from the edge and faces of structural steel members including shear studs to remain in place.

928.07.06.03.05 Concrete Crusher

The use of a concrete crusher shall not be permitted for the removal of concrete:

a) Within 2 m of concrete to remain in place.

b) Within 1 m of reinforcing steel to remain in place.

c) Within 300 mm from the edge and faces of structural steel members, including shear studs to remain in place.

d) Of an element that is integral with another element of the structure, unless approved by the Contract Administrator.

928.07.07 Concrete Removal

928.07.07.01 General

Concrete removal shall not be permitted within 1 m of newly placed concrete until the newly placed concrete has attained a compressive strength of 20 MPa.

Concrete shall be removed in such a manner to prevent damage to the concrete to remain in place and debonding of reinforcing steel beyond the demarcated removal area. Reinforcing steel, prestressing tendons, shear connectors, structural steel, Utilities, and all other components that are to remain in place shall not be damaged or loosened. Concrete debris shall be removed from the concrete removal area on an ongoing basis.

928.07.07.02 Concrete Removal - Partial Depth Types A, B, and C

928.07.07.02.01 Perimeter Treatment of Concrete Removal Areas

The perimeter treatment of a partial depth concrete removal area shall be prepared according to the rehabilitation method to be used as follows:

a) Concrete Overlay or Refacing - The perimeter of the removal area shall have a 1H:1V sloped face for the full depth of the removal area. The perimeter shall not be sawcut.

b) Shotcrete - Prior to carrying out concrete removal operations, the perimeter of the removal area shall be sawn to a depth of 10 mm or to the depth of the reinforcing steel, whichever is less. The perimeter of the removal area shall have a face perpendicular to the original concrete surface for the specified depth of the removal area.

c) Concrete Patches - Prior to carrying out concrete removal operations, the perimeter of the removal area shall be sawn to a depth of 25 mm or to the depth of the reinforcing steel, whichever is less. The perimeter of the removal area shall have a face perpendicular to the original concrete surface for the specified depth of the removal area.

928.07.07.02.02 Depth of Concrete Removal Areas

For existing concrete overlays to be patched, concrete shall be removed to the top surface of the original deck in the demarcated areas to allow the Contract Administrator to conduct a second delamination survey.

Concrete removal shall extend below the reinforcing steel within the boundaries demarcated by the Contract Administrator in the following areas:

a) The entire area of spalls and delaminations.

b) The areas of concrete components when corrosion potential of the reinforcing steel is more negative than minus 0.35 volts, as determined by the corrosion potential survey.

c) All areas of exposed reinforcing steel.

Concrete in these areas shall be removed to a uniform depth of 25 mm behind the first layer of reinforcing steel.

Concrete surrounding the second layer of reinforcing steel shall also be removed locally to provide a minimum clearance of 25 mm all around the reinforcing steel.

Concrete removal beyond the second layer of reinforcing steel shall be carried out only when directed by the Contract Administrator.

For all other concrete removals demarcated by the Contract Administrator, including scaling and honeycombing, concrete shall be removed as follows:

a) To sound concrete, when an overlay or refacing is specified in the Contract Documents.

b) To sound concrete for a uniform depth of at least 50 mm, when an overlay or refacing is not specified in the Contract Documents.

928.07.07.03 Concrete Removal - Complete Deck, Full Depth, and Structural Component

Prior to carrying out concrete removals, the perimeter of the demarcated removal area shall be sawn to a depth of 25 mm or to the depth of the reinforcing steel, whichever is less, except for localized full depth repairs in the deck.

Prior to carrying out the concrete removals for localized full depth repairs in the deck, the perimeter of the removal area on the top surface of the deck shall be sawn to a depth of 25 mm or to the depth of the reinforcing steel, whichever is less. After concrete removals from the top of the deck are completed, the perimeter of the removal area along the soffit shall be squared off by saw cutting to a depth of 25 mm or to the depth of the reinforcing steel, whichever is less. The concrete removals shall be completed from the soffit using chipping hammers.

928.07.07.04 Concrete Removal - Deck Joint Assemblies

The existing deck joint assemblies including joint filler materials and surrounding concrete shall be removed according to the requirements of this specification and the Contract Documents.

928.07.08 Remedial Work

The Contract Administrator shall be notified immediately in writing if any of the following work related defects are present along with an explanation of the cause and extent of the defect:

a) Damage to concrete beyond demarcated removal areas.

b) Damage to concrete not specified for removal and damage to reinforcing steel to remain in place.

c) Damage to structural steel and other components that are to remain in place.

d) Contaminated concrete.

e) Work that does not conform to the requirements of the Contract Documents.

All work related defects shall be repaired. A proposal for the remedial work to correct defects shall be submitted to the Contract Administrator for review. The Contractor shall not proceed with repairs until approval of the proposal has been received.

Repairs shall be made to the approval of the Contract Administrator.

928.07.09 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

928.08 QUALITY ASSURANCE

928.08.01 General

After the concrete removals are completed in the areas designated for removal, the work shall be inspected by the Contract Administrator to:

a) Determine and demarcate any additional removals within and along the perimeter of the demarcated areas.

b) Verify that the concrete has been removed to the depth and dimensions specified in the Contract Documents or as approved by the Contract Administrator.

c) Identify any work related defects in the work.

All work related defects and deficiencies shall be corrected as outlined in the Remedial Work subsection.

928.08.02 Acceptance

The following work related defects are unacceptable and shall be subject to remedial work:

a) Damage to concrete beyond demarcated removal areas.

b) Damage to concrete not specified for removal and damage to reinforcing steel to remain in place.

c) Damage to structural steel and other components.

d) Contaminated concrete.

e) Work that does not conform to the requirements of the Contract Documents.

928.09 MEASUREMENT FOR PAYMENT

928.09.01 Actual Measurement

928.09.01.01 Scarifying

Measurement of scarifying shall be by area in square metres of the structure surface area to be scarified.

Measurement shall not be made of the roughened portions of curb faces, concrete barrier and parapet walls or of areas that require a second scarifying due to the Contractor's method of operation.

The total area shall be calculated to the nearest 0.1 m^2.

928.09.01.02 Concrete Removal - Partial Depth Types A, B, and C

928.09.01.02.01 General

Measurement of partial depth concrete removal shall be by area or volume as specified in the Contract Documents.

928.09.01.02.02 By Area

Measurement shall be of the area of concrete removed in square metres.

The total area shall be calculated to the nearest 0.1 m^2.

928.09.01.02.03 By Volume

Measurement for payment shall be of the volume of concrete removed for the depth specified or to the depth approved by the Contract Administrator.

Material removed locally 25 mm around the second layer of reinforcing steel shall not be measured. However, if the Contract Documents specify a uniform removal below the second layer of reinforcing steel, measurement for payment shall be of the volume of concrete removed to the specified depth.

After concrete removal is completed, verification of concrete removal depths shall be completed by the Contract Administrator on a grid system that best describes the profile at the particular area.

Measurement shall be taken by placing a straight edge across the removal area and measuring the distance from the straight edge to the top of the remaining concrete surface, as follows:

a) A minimum of three measurements for each removal area less than or equal to 1.0 m^2.

b) A minimum of ten measurements for every square metre for each removal area greater that 1.0 m^2.

The depths for each removal area shall be measured and averaged to the nearest millimetre.

The total volume shall be calculated to the nearest 0.1 m^3.

928.09.01.03 Concrete Removal - Full Depth

Measurement of the full depth concrete removal shall be by volume in cubic metres. Alternatively, full depth concrete removal may be a lump sum item.

The total volume shall be calculated to the nearest 0.1 m^3.

928.10 BASIS OF PAYMENT

928.10.01 Scarifying - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

When exposed reinforcing steel necessitates concrete being removed from within the demarcated areas to the depth specified for the adjacent scarifying using chipping hammers, such work shall be paid as Extra Work.

928.10.02 Access to Work Area, Work Platform, and Scaffolding - Item
Concrete Removal - Complete Deck - Item
Concrete Removal - Deck Joint Assemblies - Item
Concrete Removal - Full Depth - Item
Concrete Removal - Partial Depth Type A - Item
Concrete Removal - Partial Depth Type B - Item
Concrete Removal - Partial Depth Type C - Item
Concrete Removal - Structural Component - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

When the Contract does not contain a separate tender item for access to the work area, work platform and scaffolding, the Contract price for the concrete removal items shall include full compensation for all labour, Equipment, and Material to provide access to work area, work platform, and scaffolding.

Payment for the appropriate tender item Concrete Removal - Partial Depth Type A, Concrete Removal - Partial Depth Type B, or Concrete Removal - Partial Depth Type C or any combination of the three shall include full compensation for all labour, Equipment, and Material to remove concrete locally around the second layer of reinforcing steel to provide a minimum 25 mm clearance around the reinforcing steel.

When the replacement of corrosion damaged reinforcing steel is required, such work shall be paid as Extra Work.

Work related defects repaired as remedial work shall be completed at no extra cost to the Owner.

TABLE 1
Time Requirements for Concrete Removal Surveys

Concrete Component	Maximum Area Surveyed Per Time Period m^2	Time Period Business Days
Bridge deck surface, including sidewalks, concrete barrier, and parapet walls.	3,000	3
Bridge deck soffit, including fascias.	1,500	3
Abutments, wingwalls, and retaining walls.	1,000	2
Piers	500	2
Culverts	500	2

Appendix 928-A, April 2019
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should determine if any of the following are required and, if so, specify them in the Contract Documents.

- Debris platforms. (928.04.03.02)

- Saw cutting lines and depths. (928.06.03)

- Depth and areas for concrete removal (928.07.01)

- Management requirements for debris from saw cutting operations. (928.04.03.04)

- Scarifying depths and areas. (928.07.04.01)

- Corrosion potential survey. (928.07.03.03.01)

- Lap length of steel reinforcement to remain in place. (928.07.06.03.01)

- Cutting, bending, and removal of steel reinforcement. (928.07.05)

- Overlay or refacing areas. (928.07.07.02.02)

- Concrete deck or structural component removal. (928.07.07.03)

- Concrete removal at deck joint assemblies. (928.07.07.04)

- Measurement method for Concrete Removal - Partial Depth, Types A, B, and C. (928.09.01.02)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

Note: The MUNI implemented in November 2017 replaces OPSS 929 COMMON, April 2012 with no technical content changes.

CONSTRUCTION SPECIFICATION FOR ABRASIVE BLAST CLEANING - CONCRETE CONSTRUCTION

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929-A **Commentary**

929.01 SCOPE

This specification covers the requirements for abrasive blast cleaning of concrete surfaces and reinforcing steel.

929.01.01 Specification Significance and Use

This specification has been developed for use in municipal-oriented Contracts. The administration, testing, and payment policies, procedures, and practices reflected in this specification correspond to those used by many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

929.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

929.02 REFERENCES

When the Contract Documents indicate that provincial-oriented specifications are to be used and there is a provincial-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.PROV, unless use of a municipal-oriented specification is specified in the Contract Documents. When there is not a corresponding provincial-oriented specification, the references below shall be considered to be to the OPSS listed, unless use of a municipal-oriented specification is specified in the Contract Documents.

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

ASTM International

D 4285-83 (R2006) Standard Test Method for Indicating Oil or Water in Compressed Air

The Society for Protective Coatings (SSPC)

VIS 1-2002 Guide and Reference Photographs for Steel Surfaces Prepared by Dry Abrasive Blast Cleaning

Joint Publications of the Society for Protective Coatings (SSPC) and National Association of Corrosion Engineers (NACE)

SSPC-SP 6/NACE No. 3-2007 Commercial Blast Cleaning

929.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Abrasive means a solid substance capable of grinding or wearing down.

Fiber Reinforced Polymer (FRP) Reinforcement means a structural reinforcing bar made from glass fibers or carbon fibers held in a polymeric resin matrix binder. FRP includes dowels, reinforcing bars and grids.

Layer, Reinforcing Steel means two or more reinforcing bars placed in a plane parallel to a concrete face.

Mat, Reinforcing Steel means transverse and longitudinal layers of reinforcing steel tied together.

Structure means any bridge, culvert, tunnel, retaining wall, wharf, dock, guideway or any part thereof, or other reinforced concrete component designed to carry loads, including high mast pole footings and sign support footings.

929.06 EQUIPMENT

929.06.01 Air Compressor

The air compressor for abrasive blast cleaning shall be capable of delivering material at a pressure of 620 kPa. The air pressure shall be measured in the delivery system at a distance not greater than 3 m from the nozzle end.

The compressed air shall be clean, dry, and free of oil residue when tested according to ASTM D 4285.

Nozzles used for abrasive blast cleaning shall have a minimum diameter of 8 mm and the size shall be indicated on the nozzle.

Hoses used for abrasive blast cleaning shall have an internal diameter not less than 40 mm.

929.07 CONSTRUCTION

929.07.01 General

Abrasive blast cleaning shall only be permitted when the concrete and reinforcing steel are surface dry.

Areas and components not designated for abrasive blast cleaning shall be protected from adjacent abrasive blast cleaning operations.

All new epoxy coated reinforcing steel and any FRP reinforcement in the vicinity of the abrasive blast cleaning operations shall be protected from damage.

Adequate access to the work area shall be provided to facilitate the work and for any inspection or measurement required by the Contract Administrator.

929.07.02 Abrasive Blast Cleaning of Reinforcing Steel

Abrasive blast cleaning of existing reinforcing steel applies to both epoxy coated and uncoated reinforcing steel.

All existing epoxy coated reinforcing steel within a concrete removal area shall be abrasive blast cleaned to remove the epoxy coating. Reinstatement of the epoxy coating on the existing reinforcing steel is not required.

The full circumference of the existing exposed reinforcing steel shall be abrasive blast cleaned to a commercial blast cleaned finish according to SSPC-SP 6/NACE No. 3, and the blast cleaned steel surfaces shall be according to the applicable visual standards specified in SSPC-VIS 1.

When silica sand is used as the abrasive material, the subsequent placement of concrete or shotcrete shall be done within 72 hours or the reinforcing steel shall be reblasted. When other types of abrasive materials are used, the subsequent placement of concrete or shotcrete shall be done within 36 hours or the reinforcing steel shall be reblasted.

929.07.03 Abrasive Blast Cleaning of Structural Steel in Contact with Concrete

All surfaces of existing structural steel against which new concrete is to be placed for the rehabilitation of a concrete structure component shall be abrasive blast cleaned to a commercial blast cleaned finish according to SSPC-SP6/NACE No. 3, and the blast cleaned steel surfaces shall be according to the applicable visual standards specified in SSPC-VIS 1.

The abrasive blast cleaning of structural steel shall be done immediately prior to placing coated reinforcing steel or FRP reinforcement.

Enclosure shall be provided during abrasive blast cleaning of structural steel to prevent escape of dust from the immediate work area into the natural environment, live traffic, waterways, and beyond the right-of-way.

929.07.04 Abrasive Blast Cleaning of Concrete Surfaces

929.07.04.01 General

All new and existing concrete surfaces against which new concrete is to be placed shall be abrasive blast cleaned.

The abrasive blast cleaning shall be of an extent to expose and clean the coarse aggregate and remove all dirt, laitance, and hardened concrete slurry. Any oil or grease on the surface of the concrete shall be removed using hand tools.

The abrasive blast cleaning of concrete surfaces shall be carried out not more than 48 hours prior to the placement of concrete against them.

Immediately after abrasive blast cleaning is completed, the surface shall be checked by the Contract Administrator for fractured concrete or loose aggregate. This material shall be removed using hand tools.

929.07.04.02 Concrete Surfaces for Overlays

Abrasive blast cleaning shall proceed by delineating an area of the deck not exceeding 10 m^2 and completing abrasive blast cleaning within the delineated area prior to proceeding to the adjacent areas of the deck surface.

When the concrete overlay is to be placed over cathodic protection anode mesh, the abrasive blast cleaning shall be completed prior to installing the mesh in that area.

Except when anode mesh is used, areas of concrete that are abrasive blast cleaned for the subsequent treatment of concrete overlay, shall have the overlay applied within 36 hours or shall be reblasted.

929.07.05 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

929.08 QUALITY ASSURANCE

928.08.01 General

After abrasive blast cleaning is completed, the abrasive blast cleaned concrete surfaces, reinforcing steel, and structural steel shall be examined by the Contract Administrator to verify that the requirements of this specification have been met.

929.09 MEASUREMENT FOR PAYMENT

929.09.01 Actual Measurement

929.09.01.01 Abrasive Blast Cleaning of Reinforcing Steel

Measurement for payment shall be of the area of concrete removed in square metres where reinforcing steel bars are exposed. When the removal exposes more than one mat of reinforcing steel, the measured area shall be for each mat of exposed bars that are to remain in place. There shall be no measurement for abrasive blast cleaning of reinforcing steel in volume of concrete that was not designated for concrete removal by the Contract Administrator.

When only one reinforcing steel bar is exposed in the area of concrete removal, the area shall be calculated based on the width of 200 mm by the length of the exposed reinforcing steel bar.

The total area shall be calculated to the nearest 0.1 m^2.

929.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

929.10 BASIS OF PAYMENT

929.10.01 Abrasive Blast Cleaning for Overlays - Item
Abrasive Blast Cleaning of Reinforcing Steel - Item
Abrasive Blast Cleaning of Structural Steel in Contact with Concrete - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the Work.

Abrasive blast cleaning of reinforcing steel applies to abrasive blast cleaning of existing reinforcing steel that is either epoxy coated or uncoated reinforcing steel.

When the Contract does not contain a separate tender item for providing access to the work, the Contract price for the abrasive blast cleaning items requiring the access shall include full compensation for all labour, Equipment, and Material to provide such access.

Appendix 929-A, November 2017
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

CONSTRUCTION SPECIFICATION FOR ABRASIVE BLAST CLEANING - CONCRETE CONSTRUCTION

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929-A	Commentary

929.01 SCOPE

This specification covers the requirements for abrasive blast cleaning of concrete surfaces and reinforcing steel.

929.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

929.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

929.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

ASTM International

D 4285-83 (R2006) Standard Test Method for Indicating Oil or Water in Compressed Air

The Society for Protective Coatings (SSPC)

VIS 1-2002 Guide and Reference Photographs for Steel Surfaces Prepared by Dry Abrasive Blast Cleaning

Joint Publications of the Society for Protective Coatings (SSPC) and National Association of Corrosion Engineers (NACE)

SSPC-SP 6/NACE No. 3-2007 Commercial Blast Cleaning

929.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Abrasive means a solid substance capable of grinding or wearing down.

Fiber Reinforced Polymer (FRP) Reinforcement means a structural reinforcing bar made from glass fibers or carbon fibers held in a polymeric resin matrix binder. FRP includes dowels, reinforcing bars and grids.

Layer, Reinforcing Steel means two or more reinforcing bars placed in a plane parallel to a concrete face.

Mat, Reinforcing Steel means transverse and longitudinal layers of reinforcing steel tied together.

Structure means any bridge, culvert, tunnel, retaining wall, wharf, dock, guideway or any part thereof, or other reinforced concrete component designed to carry loads, including high mast pole footings and sign support footings.

929.06 EQUIPMENT

929.06.01 Air Compressor

The air compressor for abrasive blast cleaning shall be capable of delivering material at a pressure of 620 kPa. The air pressure shall be measured in the delivery system at a distance not greater than 3 m from the nozzle end.

The compressed air shall be clean, dry, and free of oil residue when tested according to ASTM D 4285.

Nozzles used for abrasive blast cleaning shall have a minimum diameter of 8 mm and the size shall be indicated on the nozzle.

Hoses used for abrasive blast cleaning shall have an internal diameter not less than 40 mm.

929.07 CONSTRUCTION

929.07.01 General

Abrasive blast cleaning shall only be permitted when the concrete and reinforcing steel are surface dry.

Areas and components not designated for abrasive blast cleaning shall be protected from adjacent abrasive blast cleaning operations.

FRP reinforcement in the vicinity of the abrasive blast cleaning operations shall be protected from damage.

Where the Contract Documents specify preservation of existing epoxy coatings the reinforcing steel in the areas of abrasive blast cleaning operations shall be protected from damage.

Adequate access to the work area shall be provided to facilitate the work and for any inspection or measurement required by the Contract Administrator.

Abrasive blast cleaning shall be undertaken in accordance with all applicable Environmental laws, acts and regulations.

929.07.02 Abrasive Blast Cleaning of Reinforcing Steel

Abrasive blast cleaning of existing reinforcing steel applies to both epoxy coated and uncoated reinforcing steel.

Unless specified otherwise in the Contract Documents all existing epoxy coated reinforcing steel within a concrete removal area shall be abrasive blast cleaned to remove the epoxy coatings. Reinstatement of the epoxy coating on the existing reinforcing steel is not required

The full circumference of the existing exposed reinforcing steel shall be abrasive blast cleaned to a commercial blast cleaned finish according to SSPC-SP 6/NACE No. 3, and the blast cleaned steel surfaces shall be according to the applicable visual standards specified in SSPC-VIS 1.

When silica sand is used as the abrasive material, the subsequent placement of concrete or shotcrete shall be done within 72 hours or the reinforcing steel shall be reblasted. When other types of abrasive materials are used, the subsequent placement of concrete or shotcrete shall be done within 36 hours or the reinforcing steel shall be reblasted.

929.07.03 Abrasive Blast Cleaning of Structural Steel in Contact with Concrete

All surfaces of existing structural steel against which new concrete is to be placed for the rehabilitation of a concrete structure component shall be abrasive blast cleaned to a commercial blast cleaned finish according to SSPC-SP6/NACE No. 3, and the blast cleaned steel surfaces shall be according to the applicable visual standards specified in SSPC-VIS 1.

The abrasive blast cleaning of structural steel shall be done immediately prior to placing FRP reinforcement.

929.07.04 Abrasive Blast Cleaning of Concrete Surfaces

929.07.04.01 General

All new and existing concrete surfaces against which new concrete is to be placed shall be abrasive blast cleaned.

The abrasive blast cleaning shall be of an extent to expose and clean the coarse aggregate and remove all dirt, laitance, and hardened concrete slurry. Any oil or grease on the surface of the concrete shall be removed using hand tools.

The abrasive blast cleaning of concrete surfaces shall be carried out not more than 48 hours prior to the placement of concrete against them, unless approved by the Contract Administrator for special situations.

Immediately after abrasive blast cleaning is completed, the surface shall be checked by the Contract Administrator for fractured concrete or loose aggregate. This material shall be removed using hand tools.

929.07.04.02 Concrete Surfaces for Overlays

Abrasive blast cleaning shall proceed by delineating an area of the deck not exceeding 10 m^2 and completing abrasive blast cleaning within the delineated area prior to proceeding to the adjacent areas of the deck surface.

When the concrete overlay is to be placed over cathodic protection anode mesh, the abrasive blast cleaning shall be completed prior to installing the mesh in that area.

Except when anode mesh is used, areas of concrete that are abrasive blast cleaned for the subsequent treatment of concrete overlay, shall have the overlay applied within 36 hours or shall be reblasted.

929.07.05 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

929.08 QUALITY ASSURANCE

928.08.01 General

After abrasive blast cleaning is completed, the abrasive blast cleaned concrete surfaces, reinforcing steel, and structural steel shall be examined by the Contract Administrator to verify that the requirements of this specification have been met.

929.09 MEASUREMENT FOR PAYMENT

929.09.01 Actual Measurement

929.09.01.01 Abrasive Blast Cleaning of Reinforcing Steel

Measurement for payment shall be of the area of concrete removed in square metres resulting in exposing of reinforcing steel bars. When the removal exposes more than one mat of reinforcing steel, the measured area shall be for each mat of exposed bars that are to remain in place. There shall be no measurement for abrasive blast cleaning of reinforcing steel in volume of concrete that was not designated for concrete removal by the Contract Administrator.

When only one reinforcing steel bar is exposed in the area of concrete removal, the area shall be calculated based on the width of 200 mm by the length of the exposed reinforcing steel bar.

The total area shall be calculated to the nearest 0.1 m^2.

929.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

929.10 BASIS OF PAYMENT

929.10.01 Abrasive Blast Cleaning for Overlays - Item
Abrasive Blast Cleaning of Reinforcing Steel - Item
Abrasive Blast Cleaning of Structural Steel in Contact with Concrete - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the Work.

Abrasive blast cleaning of reinforcing steel applies to abrasive blast cleaning of existing reinforcing steel that is either epoxy coated or uncoated reinforcing steel.

When the Contract does not contain a separate tender item for providing access to the work, the Contract price for the abrasive blast cleaning items requiring the access shall include full compensation for all labour, Equipment, and Material to provide such access.

Appendix 929-A, November 2018
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

For existing epoxy coated steel, the default condition of this specification is removal of epoxy without reinstatement. If the designer wishes to preserve and/or reinstate with epoxy coating then this must be identified in the Contract Documents.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

CONSTRUCTION SPECIFICATION FOR STRUCTURE REHABILITATION - CONCRETE PATCHES AND OVERLAYS

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915-A **Commentary**

930.01 SCOPE

This specification covers the requirements for the surface preparation, and the placing, finishing, texturing, and curing of concrete and latex modified concrete used in structure rehabilitation.

930.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

930.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

930.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 904	Concrete Structures
OPSS 905	Steel Reinforcement for Concrete
OPSS 919	Formwork and Falsework
OPSS 928	Structure Rehabilitation - Concrete Removal
OPSS 929	Abrasive Blast Cleaning - Concrete Construction

Ontario Provincial Standard Specifications, Material

OPSS 1002	Aggregates - Concrete
OPSS 1301	Cementing Materials
OPSS 1302	Water
OPSS 1305	Moisture Vapour Barrier
OPSS 1306	Burlap
OPSS 1312	Latex Modifiers for Use in Concrete
OPSS 1350	Concrete - Materials and Production

CSA Standards

C22.2 No. 211.2-M1984	Rigid PVC - Unplasticized Conduit
G 30.5-M 1983	Welded Steel Wire Fabric for Concrete Reinforcement
CAN/CSA G 164-M92	Hot Dip Galvanizing for Irregularly Shaped Articles

ASTM International

A 53-90b Pipe, Steel, Black and Hot Dipped, Zinc Coated, Welded and Seamless
D 4285-83-1988 Method for Indicating Oil or Water in Compressed Air

Ontario Ministry of Transportation Publications

MTO Laboratory Testing Manual:
LS601-89 Materials Finer Than 75 μm Sieve in Mineral Aggregates by Washing
LS607-89 Determination of Percent Crushed Particles in Processed Coarse Aggregate

930.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Engineer means a professional engineer licensed by the Professional Engineers Ontario to practice in the Province of Ontario.

Hardwood means wood with a degree of hardness equal to species such as hard maple, oak, or beech.

Layer - Reinforcing Steel means two or more reinforcing bars placed in a plane parallel to a concrete face.

Mat - Reinforcing Steel means transverse and longitudinal layers of reinforcing steel tied together.

Rehabilitation means any modification, alteration, or improvement to a structure or its components that is designed to correct defects or deficiencies.

Structure means any bridge, culvert, tunnel, retaining wall, wharf, dock, guideway, or any part thereof.

Proposal means a Contractor's submission of changes when engineering design is required affecting the original design as stipulated in this specification.

930.04 DESIGN AND SUBMISSION REQUIREMENTS

930.04.01 Design Requirements

930.04.01.01 Proposals

930.04.01.01.01 General

Proposals by the Contractor shall bear the seal and signature of an Engineer.

Three sets of the proposal shall be submitted to the Owner 3 weeks prior to commencement of the work.

930.04.01.02 Screed Rails

An alternative screed rail system to that specified in the Finishing Equipment - Overlays clause may be used. At least 4 weeks prior to the commencement of placing screed rails, 3 complete sets of Working Drawings detailing the proposal shall be submitted to the Contract Administrator. These drawings shall include: type, dimensions of the rails to be used, spacing of screed rail chairs, details of the finishing machine, and the calculations showing the design deflection in the system. One set of these drawings shall be returned marked to indicate required changes. Eight sets of these drawings revised where necessary shall be resubmitted.

When all Owner requirements are satisfied, 2 sets of the Working Drawings shall be returned.

930.04.02 Submission Requirements

930.04.02.01 Cement Certification

Prior to using the cement in the latex modified concrete mix, one copy of the cement supplier's certificate stating that the cement is certified free from early stiffening tendencies shall be submitted to the Contract Administrator.

930.04.02.02 Mix Design

930.04.02.02.01 Concrete and Latex Modified Mortar Mix

The Contractor shall be responsible for designing the mix.

930.04.02.02.02 Latex Modified Concrete

The Contractor shall only design the mix when specified in the Contract Documents.

930.04.02.02.03 Concrete, Latex Modified Concrete, and Latex Modified Mortar Mix

When the Contractor designs the mix, the Contractor shall submit the mix proportions to the Contract Administrator at least 3 weeks prior to production of the concrete.

930.04.02.03 Certificate of Calibration for the Latex Modified Concrete Mixing Plants

A certificate of calibration shall be provided to the Contract Administrator for each of the following:

a) Cement feed meter indicating the cement meter register count and discharge time for 42.64 kg of cement for each mixing unit. The method of test shall be according to the field calibration of cement feed meter specified in the equipment manufacturer's instructions. The minimum quantity of cement for each test run shall be 50 kg.

b) Latex rate of flow and totalizer meters. The meters shall be calibrated according to the tolerances specified in the Latex Modified Concrete Mixing Plant clause. A minimum quantity of 1,000 litres of latex shall be discharged during the calibration of the meters.

c) The water totalizer meter shall be calibrated according to the tolerances specified in the Latex Modified Concrete Mixing Plant clause or a minimum quantity of 1,000 litres.

Each certificate shall be signed by an independent testing agency and shall be dated within 90 Days prior to each use of the specific mixing unit on the Contract. Aggregate gate openings and pointer adjustments, as well as the general operating condition of equipment shall also be checked by the independent testing agency according to the manufacturer's instructions.

The Contract Administrator may require recalibration of the cement feed meter.

930.04.02.04 Certification of Superplasticizer

Prior to using the superplasticizer, one copy of a certificate from the superplasticizer manufacturer stating that the superplasticizer is certified compatible with the cementitious materials and admixtures being used shall be submitted to the Contract Administrator.

930.05 MATERIALS

930.05.01 Cement

The cement shall be according to OPSS 1301.

930.05.02 Concrete and Latex Modified Concrete

930.05.02.01 General

The concrete shall be according to OPSS 1350 and as shown in Table 1.

930.05.02.02 Aggregates

930.05.02.02.01 General

Aggregates including sand for the bonding agents shall be according to OPSS 1002 and the requirements specified herein.

930.05.02.02.02 Aggregates for Overlays

Coarse aggregate shall consist of a minimum of 60% crushed particles when tested according to LS-607. Except for latex modified concrete, aggregates shall have 1.00% by mass maximum passing the 75 μm sieve when tested according to LS-601.

Coarse aggregate for overlays that form the bridge deck riding surface shall be composed of at least 80% siliceous igneous and metamorphic rocks and minerals.

930.05.02.02.03 Aggregates for Latex Modified Concrete Overlays

Aggregates shall have 0.50% by mass maximum passing the 75 μm sieve when tested according to LS-601. All aggregates, estimated quantities required for completion of each stage of the latex modified concrete overlays, shall be stockpiled within the Contract limits or at a site approved by the Contract Administrator at least 3 weeks prior to placing the overlay in that particular stage. The fine aggregate stockpile shall be covered to prevent variation of moisture content in the pile.

When additional aggregate is required, the material shall be similar and come from the same source.

930.05.03 Latex Modifier

The latex modifier shall be according to OPSS 1312 and shall be delivered to the job site in sealed containers with the trade name and date of manufacture affixed to the containers by the manufacturer.

The latex modifier shall be maintained above 5 °C and below 30 °C at all times. Sufficient latex modifier to complete the work shall be delivered to the job site prior to the commencement of the testing of the continuous concrete mixing plant and at least 7 days prior to commencement of the work in which the latex modifier shall be used.

The latex modifier shall be agitated immediately prior to use according to the manufacturer's instructions.

930.05.04 Burlap

Burlap shall be according to OPSS 1306.

930.05.05 Water

Water shall be according to OPSS 1302.

930.05.06 Bonding Agents

930.05.06.01 Cement-Sand

Cement-sand bonding agent shall consist of Portland cement and sand in the ratio of 1:1 by volume mixed with sufficient water to form a stiff mixture. The consistency of the mixture shall be such that it can be applied with a stiff brush to the existing concrete in a thin even coating that shall not run or puddle.

930.05.06.02 Latex Modified

Latex modified bonding agent shall consist of Portland cement, latex modifier, and sand in the ratio of 1.0:0.5:2.0 by volume mixed with sufficient water to produce a consistency such that when applied with a stiff brush to the existing concrete in a thin even coating it shall not run or puddle.

930.05.07 Welded Steel Wire Fabric

The welded steel wire fabric shall be welded galvanized steel and shall be according to CSA G 30.5. Galvanizing shall be according to CAN/CSA G164.

930.05.08 Anchorage Inserts

Anchorage inserts for the attachment of the welded steel wire fabric to the concrete surface shall be galvanized according to CAN/CSA G 164 and be of adequate length and strength to resist a pull-out force of 1.0 kN.

930.05.09 Tie Wire

Tie wire shall be according to OPSS 905.

930.05.10 Moisture Vapour Barrier

The moisture vapour barrier shall be polyethylene film, opaque, white pigmented, according to OPSS 1305, and shall not be less than 100 μm thick.

930.05.11 Drainage Tubes

Rigid PVC drainage tubes shall be according to CSA C22.2 No. 211.2. Galvanized steel drainage tubes shall be according to ASTM A53. Galvanizing shall be according to CSA G.164.

930.05.12 Latex Modified Mortar Mix

The Portland cement and fine aggregate, dry basis, proportions of the mix shall be designated by mass. The latex modifier to cement ratio by mass shall be one part latex modifier to three parts cement.

The water to cement ratio, by mass, shall not be greater than 0.35 which shall include the water in the latex modifier and in the fine aggregate. The latex modifier shall not be diluted. Fine aggregates shall be according to OPSS 1002 and shall contain not less than 3% and not more than 5% moisture by mass.

930.05.13 Superplasticizer

Superplasticizer shall be according to OPSS 1350.

930.06 EQUIPMENT

930.06.01 Mixers

930.06.01.01 General

The equipment used for mixing concrete shall be according to OPSS 1350, except as specified herein for latex modified concrete mixing plant and stationary mixers.

930.06.01.02 Latex Modified Concrete Mixing Plant

Mobile continuous concrete mixing plant shall be used for latex modified concrete and shall not be less than 5 m^3 capacity and shall be equipped with:

a) A storage tank for the latex modifier equipped with a mechanical agitator.

b) Two meters to measure the discharge of latex modifier; one shall record the rate of flow to an accuracy of $\pm$ 0.5 litre per minute and the other shall record the total volume discharged to an accuracy of $\pm$ 1.5%.

c) A meter that records the total quantity of water used in the concrete to an accuracy of $\pm$ 1.5%.

d) A meter, visible at all times with a ticket printout and capable of positive measurement of cement being introduced into the mix.

e) A positive control for the flow of water being introduced into the mix, coordinated with the cement and aggregate feeder mechanisms, and adjustable for minor variations in aggregate moisture.

930.06.01.03 Stationary Mixers

Stationary mixers for the mixing of cement-sand and latex modified bonding agents shall be power driven and capable of uniformly mixing the materials.

930.06.02 Compressor - Air Blasting

The compressor for air blasting shall have a minimum capacity of 3.5 m^3/minute. The compressed air shall be free from oil when tested according to ASTM D4285.

930.06.03 Sawing Equipment - Overlays

The sawing equipment shall be self-propelled and capable of sawing the overlay concrete full depth in one pass.

930.06.04 Work Bridges

A work bridge, riding on the screed rails behind the finishing machine with a working platform not higher than 1.5 m above the finished surface shall be provided to facilitate hand finishing work, concrete inspection, texturing, and placing of curing material. On placements longer than 40 m or wider than 10 m, a second work bridge shall be provided. When two work bridges are required, the trailing work bridge shall ride on the screed rails and shall be used for the purpose of placing the curing material and shall have sufficient clearance to allow for their proper placement.

930.06.05 Straight Edge

The straight edge shall be 3 m long and commercially made of metal.

930.06.06 Finishing Equipment - Overlays

930.06.06.01 Finishing Machine

The finishing machine shall be self-propelled, and travel on rails. It shall be fitted with a rotating cylinder screed, capable of finishing the surface without subsequent hand finishing, an adjustable powered screw auger and a vibrator plate or roller mounted in front of the rotating cylinder screed and behind the power screw auger. It shall be capable of forward and reverse movement under positive control. There shall be provision for raising all screeds to clear the screeded surface and for accurately repositioning the screeds. It shall have adjustable legs fitted with locking devices.

930.06.06.02 Screed Rails

The screed rails shall be straight to within 3 mm in 3 m. The maximum deflection of the screed rails under load shall be 1 mm in a 1.2 m length.

930.06.06.03 Screed Rail Chairs

Screed rail chairs shall be adjustable in height and made of metal. At locations where metal chairs cannot be accommodated, hardwood may be used to support the rail.

930.06.07 Buggies

Buggies used for transporting and placing the concrete may be hand operated or motorized. Motorized concrete buggies shall not be greater than 0.5 m^3 capacity.

930.06.08 Scales

The scales used for the calibration of the mobile continuous concrete mixing plant shall have a minimum capacity of 200 kg with an accuracy of $\pm$ 1 kg in 200 kg. Proof of the accuracy of the scales is required prior to each calibration.

930.06.09 Consolidating Equipment

Consolidating equipment shall be according to OPSS 904.

930.06.10 Hand Finishing Equipment

Only magnesium or wood floats shall be used. Bull floats shall be magnesium.

930.07 CONSTRUCTION

930.07.01 Modification of Deck Drains

Modification of deck drains shall be made prior to waterproofing the deck.

930.07.02 Drainage Tubes in Deck

Installation of drainage tubes shall be done prior to waterproofing the deck.

930.07.03 Place Concrete Overlay
Place Latex Modified Concrete Overlay

930.07.03.01 Operational Constraints

The Contract Administrator shall be notified of the intent to place the overlay 1 Business Day prior to the commencement of the placement of the overlay. The work shall not proceed until the surface preparation has been inspected by the Contract Administrator.

Only the finishing machine and buggies used to place concrete shall be allowed on the abrasive blast cleaned portion of the deck.

Areas of reinforcing steel and concrete prepared for concrete overlay shall be protected at all times during placing operations from the dropping of the bonding agent or concrete from placing equipment or other sources, except at the intended point of discharge. Any such material shall be immediately removed.

Equipment transporting concrete and runways used by equipment transporting concrete shall not be supported by deck reinforcing steel.

Placement of concrete shall not begin until the trial run procedure as specified is complete and permission to place concrete has been given in writing by the Contract Administrator. In the case of unexpected interruptions during placing operations, a construction joint shall be formed by either chopping or sawcutting at the direction of the Contract Administrator and all new concrete shall be covered with polyethylene film. Portions of the concrete overlay with incomplete or unsatisfactory consolidation or finishing shall be removed.

Overlay concrete shall not be placed when the air or deck temperature is below 10 °C or likely to fall below 10 °C or is above 30 °C or likely to rise above 30 °C during the duration of the placing operations.

Longitudinal construction joints shall be permitted only where specified in the Contract Documents.

Concrete shall not be placed adjacent to longitudinal joints in concrete overlay less than 36 hours old. At temperatures less than 10 °C, the Contract Administrator may extend this time requirement.

Neither construction traffic nor highway traffic shall be permitted on the finished surface of the overlay concrete until the curing period has elapsed.

Prior to seasonal shutdown, operations shall be scheduled in such a manner to ensure that the overlay is placed in all areas where concrete removal has commenced.

930.07.03.02 Minimum Thickness of Overlay

The minimum thickness of the overlay shall be 35 mm for the latex modified concrete overlay and 45 mm for the concrete overlay.

930.07.03.03 Surface Preparation

When anode mesh is not used, immediately prior to wetting the deck surface, all dust and loose material shall be removed from the prepared surface of the existing deck concrete by compressed air.

When anode mesh is used, within 4 hours prior to application of the overlay the concrete surface, with anode mesh in place shall be pressure washed with water using a pressure not less than 1.4 MPa to remove debris resulting from drilling of anchor holes and other accumulated dirt adhering to the anode or concrete surfaces.

The deck surface shall be maintained in a wet condition for a period of one hour prior to the application of the bonding agent. Excess water shall be removed from the surface using compressed air, immediately prior to application of the bonding agent.

930.07.03.04 Longitudinal Construction Joints

Lumber with a thickness of 10 to 15 mm less than the nominal thickness of the overlay shall be affixed to the deck to permit the concrete to spread no less than 75 mm and no more than 125 mm beyond the construction joint.

Polyethylene, asphalt, saturated felt, or other suitable debonding material shall be secured beneath the lumber and extended to within 25 mm of the sawcut line.

930.07.03.05 Placing of Screed Rails

Screed rails for the finishing machine shall be supported on screed rail supports at intervals not to exceed 1.0 m.

Supports for the screed rails shall be placed outside the finished concrete, where possible.

The screed rails shall be continued beyond the deck at each end to a length that will enable the finishing machine to be driven beyond the end of deck.

930.07.03.06 Trial Run

A trial run shall be made prior to each placing operation to ensure that the minimum thickness of the overlay is achieved. Where the trial run indicates that an unsatisfactory thickness will result, the screed rails shall be adjusted in order to obtain the minimum thickness and the trial run repeated in the area of screed rail adjustment.

930.07.03.07 Placing

A thin coating of the bonding agent, cement-sand for concrete and latex modified bonding agent for latex modified concrete shall be brushed into the prepared surface. All vertical and horizontal surfaces against which the overlay will be placed shall receive a thorough even coating with no excess of bonding agent in any areas. Excess fine aggregate separated from the bonding agent mixture after application shall be removed from the deck surface. The rate of application of the bonding agent shall be such that the brushed material does not become dry prior to being covered with overlay. At no time shall the bonding agent be placed more than 2 m in front of the overlay placement. Bonding agent not used within 30 minutes after mixing shall not be used.

The overlay shall be placed on the deck and struck off slightly above final grade using concrete rakes.

In the event of an interruption in the placing of the overlay, the exposed edge of the overlay shall be covered immediately with wet burlap. If the delay in placing exceeds 10 minutes, the bonding agent already applied to the deck shall be removed.

When undue delays occur, all overlay material ahead of the deck finishing machine shall be removed and a joint formed.

The overall combination of labour and equipment for proportioning, mixing, placing and finishing the overlay shall be capable of finishing a minimum of 4 m^3 of overlay per hour and shall be arranged that not more than 20 minutes elapses between discharge of the overlay from the mixer and the final finishing.

930.07.03.08 Remedial Work

Debonded and honeycombed areas shall be removed and replaced. Cracks shall be treated according to the requirements shown in Table 2.

930.07.04 Finish and Cure Concrete Overlay
Finish and Cure Latex Modified Concrete Overlay

930.07.04.01 Surface Finish

The overlay shall be mechanically consolidated by the finishing machine and struck off to the final grade. The surface finish shall be free from open tears, plucked aggregates, and local projections. Areas adjacent to the curb that cannot be machine finished and areas not meeting the surface finish requirements shall be finished with hand finishing equipment.

The use of water or other material to aid in finishing shall not be permitted.

The inability to produce a uniform closed surface to the overlay shall be cause for rejection of the overlay in the affected area. Overlay rejected shall be removed and new overlay placed using methods approved by the Contract Administrator.

930.07.04.02 Surface Tolerance

Except across the crown, the surface of the overlay after finishing and prior to any required texturing shall be such that when tested with a 3 m long straight edge placed anywhere in any direction on the surface there shall be no gap greater than 6 mm between the bottom of the straight edge and the surface of the concrete. Where the gap exceeds 6 mm, the overlay shall be either removed and new overlay placed or the overlay shall be refinished so that the requirement for surface tolerance is satisfied.

930.07.04.03 Surface Texture

Where the surface of the overlay forms the wearing surface of the bridge deck, the following surface texturing shall be carried out.

When a tight uniform surface has been achieved, the surface shall be given a texture with a wire broom or comb having a single row of tines. The required texture shall be transverse grooves that may vary from 1.5 mm width at 15 mm centres to 4.5 mm width at 20 mm centres with a groove depth varying from 3.0 to 4.5 mm. The texture shall extend uniformly to within 300 mm of the curb, but no closer than 150 mm.

930.07.04.04 Cure Concrete Overlay

Two layers of wet burlap that have been presoaked by immersion in water for a period of 24 hour immediately prior to placement shall be placed on the concrete overlay within 2 to 4 m from the finishing operation. Strips shall overlap 150 mm and shall be held down without marring the surface of the concrete. The burlap shall be covered with a layer of moisture vapour barrier as soon as the moisture vapour barrier can be applied without deforming the surface of the concrete. The moisture vapour barrier shall be lapped a minimum of 150 mm. Air flow in the space between the moisture vapour barrier and the burlap shall be prevented by holding the moisture vapour barrier down at the edges and all laps. The burlap shall be kept continuously wet during the curing period.

Except as specified in the Sawcutting Construction Joints in Overlays clause, labour and Equipment shall not be allowed on the overlay for 12 hours after placement. The surface shall receive a wet burlap cure for not less than 96 hours. The curing material shall then be removed and the overlay permitted to air dry for not less than 72 hours prior to any application of waterproofing.

930.07.04.05 Curing Latex Modified Concrete Overlay

One layer of wet burlap that has been presoaked by immersion in water for a period of 24 hours immediately prior to placement shall be placed on the surface of the concrete overlay within 2 to 4 m from the finishing operation. Strips shall overlap 150 mm and shall be held down without marring the surface of the concrete. The burlap shall be covered with a layer of moisture vapour barrier as soon as the moisture vapour barrier can be applied and held in place without deforming the surface of concrete. The moisture vapour barrier shall be lapped a minimum of 150 mm. Air flow in the space between the moisture vapour barrier and the burlap shall be prevented by holding the moisture vapour barrier down at the edges and all laps.

Except as specified in the Sawcutting Construction Joints in Overlays clause, labour and Equipment shall not be allowed on the overlay for 12 hours after placement. The surface shall receive a wet burlap cure for not less than 24 hours. The curing material shall then be removed and the overlay permitted to air dry for not less than 72 hours prior to any application of waterproofing. At temperatures less than 10 °C, the Contract Administrator may extend the curing period.

930.07.04.06 Sawcutting Construction Joints in Overlays

As soon as the overlay is able to withstand the weight of the sawcutting equipment without damage and the overlay has sufficient strength to be sawcut without plucking of the aggregate, all free edges shall be sawcut for the full depth of the overlay. A minimum width of 75 mm of overlay shall be removed at each sawcut.

Excess overlay shall be removed using hand tools or chipping hammers. Burlap may be rolled back in areas where excess overlay has to be removed. The overlay shall not be exposed longer than 1 hour.

930.07.04.07 Testing of Continuous Concrete Mixing Plant for Latex Modified Concrete Overlay

930.07.04.07.01 Aggregate Discharge Test

An aggregate discharge test shall be conducted on each mixing unit in the presence of the Contract Administrator. The mixing unit shall be available for this work for 1 Day prior to the first concrete placing operation. A test shall be conducted prior to the first placement of overlay and whenever the aggregate sources are changed or the mixer recalibrated.

930.07.04.07.02 Test for Flow Rate of Latex Modifier

The flow rate of latex modifier shall be determined by the Contractor. The test shall be conducted immediately prior to each placement of overlay and at other times as directed by the Contract Administrator. The tests shall be done in the presence of the Contract Administrator as follows:

a) The flow meter for the latex modifier shall be adjusted to produce a flow rate of 122 $\pm$ 3 kg of latex per cubic metre of concrete. The latex modifier shall be discharged over a period of two minutes into a container that is free from contaminants and provided by the Contractor solely for this purpose. The container shall be weighed on approved scales. The weight of the container shall then be deducted from this figure. The procedure shall be repeated and the flow rate of the latex modifier calculated as the average of the two tests.

b) The flow procedure shall be repeated, as necessary, until the flow rate is adjusted to yield the prescribed quantity of latex modifier.

930.07.04.07.03 Yield Test

A yield test shall be carried out immediately prior to each placement of overlay and at other times, as directed by the Contract Administrator. The yield test shall be carried out by the Contractor in the presence of the Contract Administrator after the mixing units have been loaded with the required aggregates, cement, water, and admixtures or latex modifier. With the cement meter set at zero, the mixer portion of the unit set at an angle of 20 degrees and all controls set for the desired mix, concrete with the specified air content and slump shall be discharged into a 0.2 m^3 container provided by the Contractor. When the container is full, the cement meter shall display a value indicating a discharge of 78 kg of cement.
Where the specified yield is not produced, adjustments shall be made in the aggregate proportions and the test repeated until such time as the yield is within 1.0% of the required yield.

930.07.05 Concrete Patches - Formed Surface
Concrete Patches - Unformed Surface
Latex Modified Mortar Patches
Concrete Refacing

930.07.06.01 General

Typical locations and areas of repair are as specified in the Contract Drawings; however, the actual locations and extent of repair shall be as determined during the layout of the repair area according to OPSS 928.

930.07.06.02 Operational Constraints

The Contract Administrator shall be notified of the intent to place patching material or refacing materials or both 1 Business Day prior to commencement of placing the patching material or refacing materials or both. The work shall not proceed until the surface preparation has been inspected by the Contract Administrator.

Concrete patching shall not be carried out when the air or existing concrete surface temperature is below 10 °C or likely to fall below 10 °C, or is above 30 °C or likely to rise above 30 °C during the placing operation.

Patching operations shall be suspended during rain which, in the opinion of the Contract Administrator, may adversely affect the quality of the work, and portions of the concrete patch with incomplete consolidation or finishing shall be removed.

Construction equipment shall be permitted on the bridge deck and other concrete components subject to the following conditions:

a) Contamination by oil or other deleterious substances shall be prevented.

b) Equipment transporting concrete and runways used by equipment transporting concrete shall not be supported by deck reinforcing steel.

c) Concrete mixing equipment and trucks shall not be placed on or travel over abrasive blast cleaned areas of concrete.

Patching operations shall be scheduled in such a manner to ensure that patching is completed in all areas where concrete removal has commenced, prior to seasonal shutdown.

930.07.06.03 Access to Work Areas, Work Platform and Scaffolding

Adequate access shall be provided to facilitate placement of the patch material, inspection, and measurement by the Contract Administrator.

930.07.06.04 Surface Preparation

Where the new concrete or mortar is to extend over the existing concrete surface, that portion of existing surface shall be roughened by scabbling, chipping or bush hammering. The concrete surfaces receiving new concrete or mortar shall be abrasive blast cleaned to an extent according to OPSS 929.

Abrasive blast cleaned areas shall have the subsequent treatment applied within 36 hours of patching or refacing or shall be reblasted.

All dust and loose material shall be removed from the prepared surface of the repair area by compressed air prior to the application of the bonding agent.

930.07.06.05 Placement of Welded Steel Wire Fabric

When welded wire fabric is required, it shall not be placed until after blast cleaning the existing concrete surface.

The edges of adjoining welded steel wire fabric shall be overlapped by two wire spacings plus 100 mm. The wires shall be kept clean of any substance which may reduce the bond of the repair material to the wire surface.

The welded steel wire fabric shall be securely fastened to the exposed reinforcing steel by ties placed at not more than a 300 mm square grid.

When the exposed reinforcing steel is not capable of providing rigid support for the wire fabric, anchorage inserts shall be used.

Where there is no existing reinforcing steel, the wire fabric shall be fastened to the concrete with anchorage inserts placed at not more than a 300 mm square grid and the minimum clearance between the wire fabric and the existing concrete shall be 20 mm.

Each anchorage insert shall be installed to resist a pull out force of at least 1.0 kN.

930.07.06.06 Formwork and Falsework

The erection and removal of formwork and falsework shall be according to OPSS 919 and shall be placed to provide the specified cover to reinforcing steel or wire mesh or both as specified in the Contract Documents. When this results in over building of the existing concrete surface, a 1H:1V slope shall be provided to meet the existing surface at the edge of the repair area.

930.07.06.07 Concrete Patches - Formed Surface
Concrete Patches - Unformed Surface
Concrete Refacing

930.07.06.07.01 Superplasticizer

Superplasticizer shall only be used when specified in the Contract Documents or approved by the Contract Administrator. When used, it shall be added according to OPSS 1350. The slump of the concrete shall be increased to 150 $\pm$ 30 mm by the addition of the superplasticizer. The superplasticizer shall be added to the concrete on the job site and in strict conformance with the manufacturer's written instructions. The concrete shall be tested for air content after the addition of superplasticizer.

930.07.06.07.02 Construction Joints

Construction joints in concrete shall only be permitted at the locations specified on the Contract Drawings and shall be according to the placing requirements of OPSS 904.

Prior to the placement of concrete, the concrete surfaces to be patched shall be maintained in a wet condition for a period of not less than one hour. Excess water shall be removed from the surface using compressed air immediately prior to application of the bonding agent and the surface shall be coated with a thin brush coating of the cement-sand bonding agent with no excess in any area. The rate of application of the bonding agent shall be such that the brushed material does not become dry prior to being covered with the patching material.

Where the concrete surface to be repaired is inaccessible for the application of bonding agent due to formwork the area to be repaired shall be maintained in a wet condition for a period of one hour and air blasted to remove excess water immediately prior to the placing of concrete.

The placement of concrete shall be according to the construction requirements of OPSS 904.

930.07.06.07.04 Surface Finish

The surface finish of formed surfaces and unformed surfaces shall be according to the construction requirements of OPSS 904.

930.07.06.07.05 Curing Concrete - Unformed Surfaces

Two layers of wet burlap shall be placed on the surface of the concrete as soon as the surface will support it without deformation. Burlap shall be presoaked by immersion in water for a period of 24 hours prior to placing. A layer of moisture vapour barrier shall be placed immediately on the wet burlap.

The concrete shall be cured using the wet burlap covered with moisture vapour barrier for a minimum period of 96 hours. The curing material shall then be removed and the concrete permitted to air dry for not less than 72 hours prior to any application of waterproofing.

Traffic shall not be permitted on the finished surface until the curing period has elapsed.

930.07.06.07.06 Curing Concrete - Formed Surfaces

Curing shall be according to the following:

a) If the formwork is left in place for 96 hours or more, no additional curing shall be required.

b) Where the formwork is removed in less than 96 hours, the concrete shall be cured as specified for unformed surfaces for the remainder of the 96 hour curing period.

930.07.06.08 Latex Modified Mortar Patches

930.07.06.08.01 Placing

Prior to the placement of the mortar, the area to be patched shall be maintained in a wet condition for a period of one hour. Excess water shall be removed from the surface using compressed air immediately prior to the placement of the bonding agent. The surface shall be coated with a thin brush coating of the latex modified bonding agent with no excess in any area. The rate of application of the bonding agent shall be such that the brushed material does not become dry prior to being covered with the mortar. The mixing of the latex modified mortar shall be carried out using mechanical mixers. The latex modified mortar for patching not used within 30 minutes after mixing shall not be used. The latex modified mortar shall not be retempered. The mortar shall be placed and consolidated in the repair area and screeded to the desired level. The surface shall be finished to a smooth and level surface immediately after placement.

The surface shall be closed with no tears or cracks. The inability to produce a uniform closed surface to the patch shall be cause for rejection of the latex modified mortar in the affected area.

930.07.06.08.02 Curing

Latex modified mortar shall be cured according to the requirements of the Curing Latex Modified Concrete Overlay clause. Neither construction traffic nor highway traffic shall be permitted over the patch until the curing period has elapsed.

930.07.07 Remedial Work

Debonded and honeycombed areas shall be removed and replaced. Cracks shall be treated according to the requirements as shown in Table 2.

The method of removal and repair shall be submitted to the Contract Administrator prior to commencement of the work.

930.07.08 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

930.08 QUALITY ASSURANCE

930.08.01 Concrete and Latex Modified Concrete Overlays
Concrete Patches
Latex Modified Mortar Patches
Concrete Refacing

930.08.01.01 Testing

930.08.01.01.01 Sampling, Delivery and Testing of Specimens

Sampling, delivery, and testing of specimens shall be according to OPSS 904. Samples and tests for slump and air content of the concrete shall be made as specified in the Contract Documents.

930.08.01.02 Inspection After Curing

The Contract Administrator shall inspect the work to determine if the completed work contains:

a) areas of debonding.

b) honeycombed areas.

c) cracks.

930.08.02 Testing of Continuous Concrete Mixing Plant for Latex Modified Concrete Overlay

930.08.02.01 General

Tests shall be conducted according to the requirements for testing specified in the Testing of Continuous Concrete Mixing Plant for Latex Modified Concrete Overlay clause of the Construction section.

930.08.02.02 Latex Modifier

Tests shall be performed on the latex modifier.

930.09 MEASUREMENT FOR PAYMENT

930.09.01 Overlays - General

For all types of overlays there shall be no measurement for the following:

a) Concrete discharged prior to the yield test.

b) Concrete produced in excess of that required for the placing operation.

c) Concrete placed on the deck more than 125 mm from the finished edge, after sawcutting of the overlay.

d) Quantity of bonding agent.

930.09.02 Actual Measurement

930.09.02.01 Modification of Deck Drains

For measurement purposes, a count shall be made of the number of deck drains modified.

930.09.02.02 Drainage Tubes in Deck

For measurement purposes, a count shall be made of the number of drainage tubes placed.

930.09.02.03 Place Concrete Overlay

Measurement shall be of the volume of concrete placed in cubic metres by delivery ticket. When their quantities are included on the delivery ticket, deductions shall be made for concrete produced in excess of that required for the placing operation and for that concrete placed on the deck more than 125 mm from the finished edge after sawcutting of the overlay. The total volume shall be calculated to the nearest cubic metre.

930.09.02.04 Place Latex Modified Concrete Overlay

Measurement shall be by volume in cubic metres and shall be calculated from the mixing unit meter register ticket and calibration certificate. A copy of the meter register ticket showing the meter reading at the commencement of the yield test and the completion of each placing operation shall be submitted to the Contract Administrator.

When their quantities are included on the meter register ticket deductions shall be made for concrete produced in excess of that required for the placing operation and for that concrete placed on the deck more than 125 mm from the finished edge, after saw cutting of the overlay.

The total volume shall be calculated to the nearest 0.1 m^3.

930.09.02.05 Concrete Patches, Formed Surface
Concrete Patches, Unformed Surface
Concrete Refacing

930.09.02.05.01 By Area

Measurement shall be by area of the concrete placed in square metres to the depth as specified in the Contract Documents.

The total area will be calculated to the nearest 0.1 m^2.

930.09.02.05.02 By Volume

Measurement shall be of the volume of concrete placed in cubic metres.

The total volume shall be calculated to the nearest 0.01 m^3.

930.09.02.06 Latex Modified Mortar Patches

930.09.02.06.01 By Area

Measurement shall be by area of the mortar placed in square metres to the depth as specified in the Contract Documents.

The total area shall be calculated to the nearest 0.1 m^2.

930.09.02.06.02 By Volume

Measurement shall be by volume of the mortar placed in cubic metres. The volume of in place latex modified mortar shall be calculated to the nearest 0.01 m^3.

930.09.03 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

930.10 BASIS OF PAYMENT

930.10.01

Modification of Deck Drains - Item
Drainage Tubes in Deck - Item
Place Concrete Overlay - Item
Place Latex Modified Concrete Overlay - Item
Finish and Cure Concrete Overlay - Item
Finish and Cure Latex Modified Concrete Overlay - Item
Concrete Patches, Formed Surface - Item
Concrete Patches, Unformed Surface - Item
Latex Modified Mortar Patches - Item
Concrete Refacing - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

TABLE 1
Concrete and Latex Modified Concrete Overlay

	Concrete Overlay, Patches and Refacing	**Latex Modified Concrete Overlay**
Cement Content	OPSS 1350	390 ± 6 kg/m^3
Maximum Nominal Size of Coarse Aggregate	13.2 mm	13.2 mm
Slump	70 mm ± 20 mm	180 mm ± 40 mm *
Air Content	OPSS 1350	6.5% maximum *
Chemical Admixture	OPSS 1303	N/A
Latex Modifier	N/A	122 ± 3 kg/m^3
Nominal Minimum 28 Day Strength	30 MPa	30 MPa
* Five minutes after mixing.		

TABLE 2
Treatment of Cracks

	Maximum Width of a Crack mm	**Depth mm**		
		≤ 15.0	> 15.0 < Full Depth	Full Depth
Overlays and Patches to be Waterproofed and Paved	≥ 1.00	Repair	Repair	Repair
Exposed Facings, Overlays, and Patches	> 0.30	Repair or if the linear measurement of crack per m^2 is 20 m or greater, remove and replace concrete.	Repair or if the linear measurement of crack per m^2 is 10 m or greater, remove and replace concrete.	Repair or if the linear measurement of crack per m^2 is 5 m or greater, remove and replace concrete.

Appendix 930-A, November 2014
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

Note: The MUNI published in November 2020 replaces OPSS 931 COMMON, November 2013 with no technical content changes.

CONSTRUCTION SPECIFICATION FOR STRUCTURE REHABILITATION - SHOTCRETE

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931-A **Commentary**

931.01 SCOPE

This specification covers the requirements for concrete structure rehabilitation using normal and silica fume shotcrete.

931.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

931.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

931.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications.

Ontario Provincial Standard Specifications, Construction

OPSS 904	Concrete Structures
OPSS 905	Steel Reinforcement for Concrete
OPSS 919	Formwork and Falsework
OPSS 928	Structure Rehabilitation - Concrete Removal
OPSS 929	Abrasive Blast Cleaning - Concrete Construction
OPSS 932	Crack Repair - Concrete

Ontario Provincial Standard Specifications, Material:

OPSS 1002	Aggregates - Concrete
OPSS 1301	Cementing Materials
OPSS 1302	Water
OPSS 1306	Burlap
OPSS 1315	White Pigmented Curing Compounds for Concrete

Ontario Ministry of Transportation Publications

MTO Laboratory Testing Manual:

LS-430	Method of Test for Bond Strength by Tensile Load

CSA Standards

A23.2-14C- 09 Obtaining and Testing Drilled Cores for Compressive Strength Testing*
* [Part of A23.1-09/A23.2-09 Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete]

ASTM International

A123/A123M-12	Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
A153/A153M-09	Zinc Coating (Hot-Dip) on Iron and Steel Hardware
A185/A185M-07	Steel Welded Wire Reinforcement, Plain, for Concrete
C1202-10	Standard Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration

931.03 DEFINITIONS

For the purpose of this specification the following definitions apply:

Cold Weather means those conditions when the air temperature is at or below 10° C. It is also considered to exist when the air temperature is at or is likely to fall below 10° C within 96 hours after concrete placement. Temperature refers to shade air temperature.

Dry-Mix Shotcrete means shotcrete in which the mixing water is added at the nozzle.

Hot Weather means those conditions when the air temperature is at or above 28 °C. It is also considered to exist when the air temperature is at or is likely to rise above 28 °C within 24 hours after concrete placement. Temperature refers to shade air temperature.

Nozzle Operator means the worker on the shotcrete crew who manipulates the nozzle, controls consistency with the dry process, and controls final placement of the material.

Rehabilitation means any modification, alteration, or improvement to a structure or its components that is designed to correct defects or deficiencies.

Structure means any bridge, culvert, tunnel, retaining wall, wharf, dock, guide way, or any part thereof.

Wet-Mix Shotcrete means shotcrete in which all of the ingredients, including water, are mixed before introduction into the delivery hose. Compressed air is introduced to the material flow at the nozzle.

931.04 DESIGN AND SUBMISSION REQUIREMENTS

931.04.01 Submission Requirements

931.04.01.01 Mix Design

The mix proportions and the name of the supplier of the prebagged shotcrete mix shall be forwarded to the Contract Administrator for review at least 14 Days prior to the application of shotcrete.

In addition, the Contractor shall submit with the mix design the following:

a) A certificate from the cement supplier stating that the cement is certified to be free from early stiffening tendencies according to the requirements of OPSS 1301.

b) Performance test data from the manufacturer of the prebagged material, or test data from another contract, verifying that the material meets the requirements of this specification.

All supporting test data shall not be more than 12 months old at the time the mix design was submitted to the Contract Administrator.

931.04.01.02 Shotcrete Equipment

A list of equipment and accessories to be used, including the following information, shall be submitted to the Contract Administrator at least 14 Days prior to the application of shotcrete:

a) Equipment type and capacity.

b) Nozzle type and size.

c) Continuous feed predampener details, only when the dry mix process is used.

931.04.01.03 Nozzle Operator

The names of the nozzle operators and proof of their qualification shall be submitted to the Contract Administrator at least 14 Days prior to the commencement of the shotcreting operation.

931.04.01.04 Cold Weather Protection

Details of the method to be used in the production of the shotcrete to control the shotcrete temperature shall be submitted to the Contract Administrator at least 14 Days prior to the commencement of the shotcreting operation in cold weather. The submission shall be accompanied by samples of insulation, if requested by the Contract Administrator, and shall contain the following information:

a) Weather conditions for which the description applies.

b) Type of insulation, metric “R” value, and number of layers to be used.

c) Description of housing and heating.

d) Method of withdrawal of protection to avoid sudden temperature change in the shotcrete.

e) Method of ensuring cold weather protection measures are maintained and effective when work requiring adjustment to the protective measure is being performed.

931.04.01.05 Hot Weather Shotcreting

A description of the method to be used in the production of the shotcrete to control the shotcrete temperature shall be submitted to the Contract Administrator 14 Days prior to the application of shotcrete in hot weather.

931.04.01.06 Curing

A description of the methods to be used for fog-misting and curing, including equipment and procedures, shall be submitted to the Contract Administrator 14 Days prior to the application of shotcrete.

931.04.01.07 Return of Submissions

Two copies of each submission shall be returned as one of the following:

a) Stamped with the wording: Reviewed. In this case, work can commence on receipt of the drawings by the Contractor.

b) Stamped with the wording: Reviewed as Noted. In this case, work can start on receipt of the reviewed submission by the Contractor. The submission shall be updated as noted and shall be sealed and signed by the design Engineer and the design-checking Engineer stating the submission has been revised according to the noted comments.

c) Showing only required changes. In this case, the submission shall be updated as required and the submission process repeated.

931.05 MATERIALS

931.05.01 Anchors

Anchors for the attachment of the welded steel wire fabric to the concrete surface shall be galvanized according to ASTM A153/A153M and be of adequate length and strength to resist a pull-out force of 1.0 kN.

931.05.02 Burlap

Burlap shall be according to OPSS 1306.

931.05.03 Cementing Material

Cementing material shall be according to OPSS 1301.

931.05.04 Curing Compound

Curing compound shall be according to OPSS 1315.

931.05.05 Fine Aggregate

Fine aggregate shall be according to OPSS 1002.

931.05.06 Formwork

Formwork shall be according to OPSS 919.

931.05.07 Proprietary Patching Materials

Proprietary patching materials shall be as specified in the Contract Documents.

931.05.08 Shotcrete

931.05.08.01 General

The shotcrete mix shall be supplied prebagged. The prebagged mix shall contain cementing materials and fine aggregate. The bags shall be maintained in a dry condition up to the time of its use and shall be stored within a temperature range of 5 to 30 °C. Any bags that contain lumps of pre-hydrated shotcrete or appear to be frozen or otherwise damaged shall not be used in the Contract.

Each bag shall be stamped with the name of the manufacturer, mix identification, and date of packaging. The prebagged mix shall be used within 3 months of packaging.

931.05.08.02 Normal Shotcrete

The shotcrete shall have a minimum 28-Day compressive strength of 30 MPa. The water to cement ratio, by mass, shall not be greater than 0.35 when the wet mix process is used.

931.05.08.03 Silica Fume Shotcrete

The silica fume shotcrete shall have a minimum 28-Day compressive strength of 35 MPa and maximum rapid chloride permeability at 28 Days of 1,000 coulombs. The shotcrete mix shall contain 8% silica fume by mass of total cementing materials.

931.05.09 Tie Wire

Coated tie wire according to OPSS 905 shall be used.

931.05.10 Water

Water shall be according to OPSS 1302.

931.05.11 Welded Steel Wire Fabric

Welded steel wire fabric shall be welded galvanized steel of 51 x 51 mm, MW 5.5 x MW 5.5, and shall be according to ASTM A185/A185M. Galvanizing shall be according to ASTM A123/A123M.

931.06 EQUIPMENT

931.06.01 Compressor - Air Blasting

The compressor for air blasting shall have a minimum capacity of 3.5 m^3/min. The compressed air shall be free from oil and other contaminants.

931.06.02 Fog Misting Equipment

The Contractor shall provide fog misting equipment for curing of the shotcrete. Fog misting equipment shall include at least one hand held portable unit.

931.06.03 Hand Finishing Equipment

Where hand finishing is required, only magnesium, wood, or sponge rubber floats shall be used.

931.06.04 Mixers

931.06.04.01 Dry Mix Process

A continuous feed predampener shall be used. The predampening equipment shall be capable of bringing the dry bagged material to consistent and suitable moisture content and shall operate at sufficient capacity to allow work to proceed without delays.

The delivery equipment shall be capable of discharging the mixture into the delivery hose at a rate sufficient to ensure a continuous smooth stream of uniformly mixed shotcrete mixture being delivered to the nozzle, at the velocity required.

The discharge nozzle shall be equipped with a manually operated water injection system, for directing an even distribution of liquid through the mixture. The liquid valve shall be capable of ready adjustment to vary the quantity of liquid and shall be convenient for the nozzle operator. The nozzle shall be capable of delivering a conical discharge stream with uniform appearance throughout. The liquid pressure at the discharge nozzle shall be sufficiently greater than the operating air pressure to assure that the liquid is thoroughly mixed with the other materials. The liquid pressure shall be uniform.

931.06.04.02 Wet Mix Process

The mixing equipment shall be capable of thoroughly mixing the specified materials in sufficient quantity to maintain continuous placing. The delivery equipment shall be capable of delivering the pre-mixed materials accurately, uniformly, and continuously through the delivery hose.

The wet mix process shall not be used for silica fume shotcrete.

931.06.05 Straight Edge

The straight edge shall be 1.0 m long, commercially made, and metal.

931.07 CONSTRUCTION

931.07.01 General

Typical locations and areas of repair are as specified in the Contract Documents; however, the actual locations and extent of repair shall be as determined during the layout of the repair areas according to OPSS 928 and as directed by the Contract Administrator.

931.07.02 Operational Constraints

The Contract Administrator shall be notified of the intent to apply shotcrete 3 Business Days prior to the commencement of the shotcreting operation. The application of shotcrete shall not proceed until the concrete surface preparation has been completed according to this specification and verified by the Contract Administrator.

Prior to shotcreting, the Contractor shall demonstrate to the Contract Administrator that the substrate temperatures meet the requirements specified in the Contract Documents by measuring and recording the substrate temperatures using a contact thermometer or infrared thermometer.

Shotcreting shall not be carried out when the air temperature or existing concrete surface temperature is below 10 °C or is likely to fall below 10 °C, or is above 28 °C or likely to rise above 28 °C throughout the duration of the shotcreting operation, unless protection is provided in accordance with the Contractor's submitted plan.

The air in contact with the repaired surfaces shall be maintained at temperatures above 10 °C for at least 96 hours after the application of shotcrete. The use of unvented heaters shall be prohibited.

Shotcreting operations shall be suspended during adverse weather conditions, unless protection is provided.

Prior to seasonal shutdown, operations shall be scheduled in such a manner to ensure that the shotcreting operations are completed in all areas where concrete removal has commenced. No steel reinforcement shall be left exposed during seasonal shutdown.

931.07.03 Access to Work Areas, Work Platform, and Scaffolding

Adequate access shall be provided to facilitate inspection and measurement by the Contract Administrator.

931.07.04 Surface Preparation

All concrete surfaces against which shotcrete is to be placed shall be clean, solid, and free from loose or unsound fragments, coatings, and any other foreign substances or debris, and shall be sufficiently rough to ensure that a full bond is developed with the new shotcrete.

All existing concrete surfaces to be covered by shotcrete shall be uniformly roughened by means of scabbling, chipping, or bush hammering. A surface profile of 5 ± 2 mm shall be achieved by exposing the aggregates across the entire surface.

All concrete surfaces, including areas 50 mm beyond the perimeter of the removal area and existing steel reinforcement to receive shotcrete, shall be abrasive blast cleaned according to OPSS 929 prior to installation of welded steel wire fabric.

Abrasive blast cleaned areas shall have shotcrete applied within 36 hours or shall be reblasted. In areas requiring reblasting, the Contractor shall remove the welded steel wire fabric prior to abrasive blast cleaning and reinstall the wire fabric.

Immediately prior to wetting the concrete, all dust and loose material shall be removed from the prepared surface of the repair area by using compressed air.

The area to be shotcreted shall be maintained in a wet condition for a period of 2 hours prior to the application of the shotcrete. Prior to the shotcreting operation, excess water shall be removed from the surface using compressed air.

931.07.05 Placement of Welded Steel Wire Fabric

When welded steel wire fabric is specified in the Contract Documents, it shall not be installed until after the concrete surface and exposed steel reinforcement in the repair area have been abrasive blast cleaned. The wire fabric shall not be abrasive blast cleaned at any time.

The Contractor shall install wire fabric in all repair areas greater than 0.1 m^2 that have a minimum dimension of 200 mm. The wire fabric shall be securely fastened to the exposed steel reinforcement by ties placed no further than 300 mm apart in a grid pattern. When the exposed steel reinforcement is not capable of providing rigid support for the wire fabric, anchors shall be used to support the wire fabric.

When there is no exposed steel reinforcement, the wire fabric shall be fastened to the concrete with anchors placed no further than 300 mm apart in a grid pattern. The minimum clearance between the wire fabric and the existing concrete shall be 20 mm.

The wire fabric shall be installed flat, tight, and at locations shown in the Contract Documents using spacers and anchors. The edges of adjoining wire fabric sheets shall be overlapped by one wire spacing plus 50 mm. The wire fabric shall be kept clean of any substance that may reduce the bond of the shotcrete to the wire surface.

931.07.06 Approval of Nozzle Operator

Shotcreting shall be carried out by a nozzle operator who has been certified by participation in the MTO Shotcrete Nozzlemen Certification Program.

931.07.07 Placing

Prior to the application of shotcrete, the Contractor shall protect all structural components not receiving shotcrete and appurtenances from the shotcreting operation. Repair areas being prepared to receive shotcrete shall also be protected.

When practical, shotcrete shall be placed without the use of formwork. When the requirements of this specification cannot otherwise be met, formwork may be used and shall be according to OPSS 919. Formwork shall be adequately braced against excessive vibration and constructed to permit the escape of air and rebound during the shotcreting operation.

During the application of shotcrete, a steady continuous flow of shotcrete shall be maintained. Any predampened mixture that is not used within one half hour, shall not be incorporated into the work.

Shotcrete shall be applied so that there is no sagging or separation of the material in place. All rebound material shall be removed from the repair area as the work proceeds. Rebound or waste material shall not be worked back into construction or salvaged and re-used.

The concrete surface surrounding the repair area shall be cleaned immediately after the application of shotcrete using suitable hand tools.

When shotcrete in a repair area cannot be applied in a single operation or delays are experienced, moist curing by means of continuous fog mist shall be applied according to the curing requirements of this specification. If the previous layer has hardened, the surface of the shotcrete shall be thoroughly cleaned of any laitance by wire brushing and wetted prior to application of an additional layer of shotcrete.

The shotcrete shall be placed level or slightly above the level of the original concrete surface to provide a minimum of 50 mm cover to the welded steel wire fabric or reinforcing steel, unless otherwise specified in the Contract Documents.

At the end of the shotcreting operation, the shotcrete shall be terminated at a 1H:1V slope. Before placing an adjacent section, this sloped portion shall be thoroughly cleaned by wire brushing any laitance and wetted.

The total required depth of shotcrete shall be placed within the same working day.

931.07.08 Finishing

Unless otherwise specified in the Contract Documents, when the final layer of shotcrete has attained its initial set, the surface of the shotcrete shall be finished with hand finishing equipment.

When tested with a straight edge, the maximum gap between the straight edge and any point on the surface shall be 6 mm.

931.07.09 Curing

Shotcrete shall be initially moist cured by continuous fog mist for a minimum period of 24 hours. The curing shall commence as soon as the fog mist can be applied without deforming the surface of the shotcrete. When an area of fresh shotcrete is exposed to direct sunlight or to wind, the curing shall be applied immediately after the final application of shotcrete in that area.

After the initial 24 hour fog misting period, moist curing shall continue for an additional period of 72 hours by means of fog mist or wet burlap.

When wet burlap is used, the burlap shall be placed in a manner to ensure that it is in full contact with the surface of the shotcrete for the full duration of the curing period. The curing with burlap and water shall be according to OPSS 904.

Immediately after removal of moist curing, the shotcrete surface shall be coated with a curing compound according to OPSS 904.

931.07.10 Cold Weather Protection

931.07.10.01 General

The Contractor shall protect the shotcrete during cold weather. The protection system shall be designed for the worst conditions that can be reasonably anticipated from local weather records, forecasts, site conditions and past experience for the time period during which the protection is required.

931.07.10.02 Control of Temperature

During cold weather, the Contractor shall for a minimum period of seven days following the shotcrete operation, monitor and control the temperature of the shotcrete to ensure that the temperature does not fall below 10 °C. The Contractor shall take measures to ensure that the shotcrete temperature remains within the acceptable limits.

The Contractor shall supply thermocouples, wires, and digital temperature indicators with an accuracy of ± 0.5°C to monitor the shade air temperature and shotcrete temperature. The digital temperature indicators shall be left in place or provided upon request to the Contract Administrator to facilitate additional readings for verification purposes.

Thermocouples shall be embedded near the shotcrete surface at a minimum of two locations for each day of shotcreting, as directed by the Contract Administrator.

For cold weather conditions, protection of concrete shall at least be according to Table 1.

931.07.10.03 Temperature Records

The Contractor shall record the shade air temperature and shotcrete temperature at a minimum frequency of once every four hours for the first 24 hours after the shotcreting operation and then once every eight hours for the remainder of the curing and protection period and during the removal of the cold weather protection.

The Contractor shall provide the Contract Administrator with the necessary access to the location and equipment to verify temperature readings.

Temperature records shall be forwarded to the Contract Administrator at the end of every day. At the end of the cold weather protection period, the Contractor shall submit to the Contract Administrator a complete temperature record consisting of a summary of the recorded temperatures and a graphical plot of temperature vs. time.

931.07.11 Coring and Testing

931.07.11.01 General

The cores shall be obtained according to CSA A23.2-14C at random locations specified by the Contract Administrator. The Contractor shall locate all steel reinforcement in the area, prior to taking any cores, to avoid cutting steel reinforcement.

Testing shall not be required on a structure when the total measured vertical area of shotcrete on a structure is less than 20 m^2 or the total measured horizontal area of shotcrete on a structure is less than 20 m^2.

931.07.11.02 Lot and Sublot Size

A lot shall consist of the total quantity of normal shotcrete or silica fume shotcrete in the Contract Documents. Each lot shall be divided into sublots of approximately equal size and not greater than 100 m^2. Separate sublots are required for vertical and horizontal repairs. Separate sublots are required for individual structures.

The Contract Administrator shall determine the sublot size after discussion with the Contractor and prior to the commencement of the shotcreting operation.

931.07.11.03 Compressive Strength

The Contractor shall be responsible for all aspects of coring, storage, and transportation of cores to determine compressive strength.

For evaluation of compressive strength testing, the Contractor shall remove four cores from the hardened shotcrete when the shotcrete is between 7 to 10 Days of age, for each sublot. The cores shall be 75 mm in diameter and at least 100 mm long. Cores may contain wire fabric but shall not contain reinforcing steel.

The Contractor shall deliver the cores to the designated quality assurance laboratory as specified in the Contract Documents. The cores shall be tested according to CSA A23.2-14C at 28 Days of age. The forms on which the field data for the cores is recorded shall be submitted to the laboratory with the shotcrete cores. Test results shall be recorded on forms acceptable to the Owner and forwarded to the Contract Administrator within 4 Days from the date of testing.

931.07.11.04 Tensile Bond Strength

The minimum tensile bond strength of the shotcrete shall be 1.0 MPa.

The tensile bond strength testing shall be carried out by the Contractor, in the presence of the Contract Administrator, on 3 in-situ cores taken within one metre of each other for each sublot. The testing shall be carried out by technicians employed by a laboratory acceptable to the Owner.

The cores shall be 100 mm in diameter and extend into the parent concrete to the depth specified in MTO LS-430. The testing shall be according to MTO LS-430 and shall be carried out when the shotcrete is 7 to 10 Days of age. The equipment used to measure the tensile bond strength shall be equipped with a maximum load indicator.

The Contractor shall ensure that the epoxy adhesive is cured according to the manufacturer's recommendations prior to carrying out the test. If failure occurs in the epoxy adhesive and the specified strength of 1.0 MPa has not been reached, the test shall be repeated within 300 mm of the original core location. Retesting is not required when the specified strength of 1.0 MPa has been achieved.

After the tensile bond strength testing is completed, the cores shall be extracted for the full depth of the coring to demonstrate to the Contract Administrator that the depth of coring was adequate.

All individual tensile bond strength results obtained by the Contractor and average shall be recorded on forms acceptable to the Owner and forwarded to the Contract Administrator within 4 Business Days of the date of testing.

931.07.11.05 Rapid Chloride Permeability - Silica Fume Shotcrete

For evaluation of rapid chloride permeability, the Contractor shall remove cores from the hardened silica fume–shotcrete and test cores according to ASTM C1202. Testing shall be carried out by a laboratory that is acceptable to the Owner.

Two cores, 100 mm in diameter and at least 75 mm long, shall be removed from each sublot, when the silica fume shotcrete is 7 to 10 Days of age. The portion of the core to be tested shall contain no reinforcing steel, welded wire steel fabric, or other embedments.

Cores shall be delivered in a plastic bag sealed to avoid loss of moisture, to a laboratory acceptable to the Owner, within 24 hours of coring. The cores shall be stored at a temperature of 23 ± 2 °C in a moist condition until time of testing. A 10 mm thick slice shall be cut from the top of each core before testing. Testing shall be carried out according to ASTM C1202 when the shotcrete is 28 to 32 Days of age.

Rapid chloride permeability results obtained by the Contractor shall be recorded and forwarded to the Contract Administrator within 37 Days of application of shotcrete. Rapid chloride permeability core samples and original test record shall be retained by the Contractor until final completion of the Contract and shall be provided to the Contract Administrator, upon request.

931.07.11.06 Filling of Core Holes

All remnants of cores, including ones that remain in place, shall be completely removed and core holes filled immediately after coring. Prior to filling, the inside surfaces of each core hole shall be cleaned of all laitance and other debris from the coring operation by wire brushing. The core holes shall be cleaned using compressed air, pre-wetted, and filled with a proprietary patching material. The patching material shall be comparable to the surrounding concrete in terms of strength and permeability. The patching material shall be mixed and cured according to the manufacturer's recommendations. The patch shall be finished flush with the surface of the concrete and all excess material removed.

931.07.12 Remedial Work

If plastic shotcrete is rejected by the Contract Administrator, the Contractor shall stop the work and take all necessary measures to correct deficiencies while the shotcrete is in the plastic state.

The Contractor shall notify the Contract Administrator in writing immediately if any of the defects or conditions listed in the Quality Assurance section are present in the Work with an explanation of the cause and extent of the deficiencies. These areas shall be repaired by the Contractor.

A proposal for the remedial work for the above defects and conditions shall be submitted to the Contract Administrator for review. The Contractor shall not proceed with repairs until approval of the proposal has been received.

The Contractor shall repair all cracks greater than or equal to 0.3 mm after the curing period has elapsed. Repair of cracks shall be according to OPSS 932. If the linear measurement of cracks greater than or equal to 0.3 mm in width per square metre is 2 m or greater, the entire shotcrete in the repair area shall be removed and replaced.

931.07.13 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

931.08 QUALITY ASSURANCE

931.08.01 Inspection

931.08.01.01 During Shotcrete Application

The Contract Administrator shall inspect the plastic shotcrete during the application process and shall reject all or a portion of the work based on the presence of one or more of the defects identified below:

a) Failure to properly control and remove build-up of overspray and rebound.

b) Incomplete consolidation around steel reinforcement and anchors.
c) Excessive shotcrete rebound.

d) Incorporation of sand lenses, excessive voids, delaminations, sags, and sloughing.

e) Failure to apply shotcrete to the required line, grade, and tolerance.

931.08.01.02 Completed Work

The Contract Administrator shall inspect the completed work to determine if the work contains any of the following:

a) Debonding or hollow-sounding areas.

b) Porous or rebound material visible in cores.

c) Areas that have visibly sagged in cores.

d) Cracks.

931.08.02 Acceptance or Rejection

The Contract Administrator shall have the authority to accept or reject shotcrete that does not conform to the Contract requirements, either during the shotcrete application process or on the basis of the completed work, or if any of the defects identified in the Inspection subsection are identified in any of the cores extracted.

931.08.02.01 Normal Shotcrete

For normal shotcrete, the Contract Administrator shall reject all or a portion of the lot based on the presence of one or more of the defects identified in the Inspection subsection or one or more of the following conditions:

a) Average compressive strength less than 30 MPa.

b) An individual compressive strength result more than 3.5 MPa below the specified strength.

c) Average tensile bond strength less than 0.6 MPa.

d) Any work that does not conform to the requirements of this specification.

931.08.02.02 Silica Fume Shotcrete

For silica fume shotcrete, the Contract Administrator shall reject all or a portion of the lot based on the presence of one or more of the defects identified in the Inspection subsection or one or more of the following conditions:

a) Average compressive strength less than 35 MPa.

b) An individual compressive strength result more than 3.5 MPa below the specified strength.

c) Average tensile bond strength less than 0.6 MPa.

d) Average rapid chloride permeability greater than 2,500 coulombs.

e) Any work that is not according to the requirements of this specification.

931.09 MEASUREMENT FOR PAYMENT

931.09.01 Actual Measurement

931.09.01.01 Normal Shotcrete
Silica Fume Shotcrete

Measurement shall be by volume in cubic metres of the concrete removed according to the Measurement for Payment section of OPSS 928, except when the existing cover to steel reinforcement is less than 50 mm, the depth used in calculating the volume shall be adjusted by adding the difference between the 50 mm required and the existing cover.

No measurement shall be made for areas of shotcrete that were removed according to the Remedial Work subsection.

No measurement shall be made for shotcrete required to patch areas of concrete removal when the removal was not approved by the Contract Administrator.

931.10 BASIS OF PAYMENT

931.10.01 Normal Shotcrete - Item
Silica Fume Shotcrete - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour Equipment, and Material to do the work, including abrasive blast cleaning of the concrete surfaces.

Payment for the work of abrasive blast cleaning of steel reinforcement shall be according to OPSS 929.

When the Contract does not contain a separate tender item for providing access to the work, the Contract price for the shotcrete items requiring the access shall include full compensation for all labour, Equipment, and Material to do the work.

TABLE 1
Minimum Cold Weather Protective Measures

Anticipated Minimum Air Temperature °C	**Protective Measure Thickness of New Shotcrete < 0.25 m**
+10 to 0	PM2
-1 to -10	PM4
-11 to - 20	PM5
Less than - 20	PM5
Maximum Allowable Drop in Concrete Temperature/24 hours	15 °C

Notes:

A. Protective Measures:

PM2 - Cover concrete with insulation having an R-Value of 0.67.
PM3 - Cover concrete with insulation having an R-Value of 1.33.
PM4 - Cover concrete with insulation having an R-Value of 2.00.
PM5 - House and heat as specified in the Housing and Heating clause of OPSS 904.

B. All R-Values are metric.

C. The conversion factor from metric to imperial units is:

Metric R-Value x 5.678 = Imperial R-Value.

Appendix 931-A, November 2020
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Proprietary patching materials. (931.05.07)

- Location of the quality assurance laboratory. (931.07.11.03)

The designer should determine if the following is required and, if so, specify it in the Contract Documents:

- Welded steel wire fabric. (931.07.05)

The wire fabric shall not be used in repair areas on which a cathodic protection system is to be installed.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

Note: The MUNI published in November 2020 replaces OPSS 932 COMMON, November 2009 with no technical content changes.

CONSTRUCTION SPECIFICATION FOR CRACK REPAIR - CONCRETE

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932-A **Commentary**

932.01 SCOPE

This specification covers the requirements for the pressure injection, routing, and sealing of cracks in concrete for the purpose of structural rehabilitation and water seepage control.

932.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

932.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

932.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 920	Deck Joint Assemblies, Preformed Seals, Joint Fillers, Joint Seals, Joint Sealing Compounds, and Waterstops - Structures
OPSS 929	Abrasive Blast Cleaning - Concrete Construction

Ontario Provincial Standard Specifications, Material

OPSS 1212	Hot Poured Rubberized Asphalt Joint Sealing Compound
OPSS 1302	Water

ASTM International

C920-08	Elastomeric Joint Sealants
D4285-83 (2006)	Test Method for Indicating Oil or Water in Compressed Air

932.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Active Crack means a crack in concrete with plane surfaces that are in a state of movement relative to each other.

Crack Depth means the distance that the crack extends from the injection surface into the concrete to the point where the crack is 0.10 mm wide.

Effective Pressure means the fluid grout pressure at point of entry at the injection port. This shall be calculated as gauge pressure minus head losses in injection system.

Engineer means a Professional Engineer licensed by the Professional Engineers Ontario to practice in the province of Ontario.

Flushing means removing debris from the crack section by means of air or a liquid under pressure.

Gauge Pressure means the actual fluid grout pressure reading on the pump gauge.

Injection Port means a mechanical device that is firmly connected into the crack section for the purpose of providing access into a crack for the grouting material.

Passive Crack means a concrete crack in concrete with plane surfaces that are not moving relative to each other.

Payment Adjustment Factor means a multiplier applied to the unit Contract price to determine the actual unit payment price.

Plural Component Pump means a grout pump that separately delivers the grout material components separately to a common static mixer.

Pot Life means the period of time during which the polyurethane or epoxy resin remains pumpable.

Refusal Criteria means zero flow of grout at the proposed effective pressure for a duration of 5 minutes.

Regulated Operating Pressure means the maximum pressure, measured at the pump discharge, that the pump is capable of producing.

932.04 DESIGN AND SUBMISSION REQUIREMENTS

932.04.01 Submissions

932.04.01.01 Crack Repair Work Plan

Four copies of the crack repair work plan shall be submitted to the Contract Administrator at least 3 weeks prior to the commencement of the work.

The crack repair work plan shall bear the seal and signature of an Engineer and include at least the following information.

a) A description of the method of repair, including the following minimum information:

   i. Basis of selection.
   ii. Proposed effective pressure.
   iii. Surface finishing.
   iv. Location and size of injection ports.
   v. Surface treatment of the concrete prior to surface sealing.
   vi. Method of storing and handling grouts, cleaning solvents, and waste materials.

b) A list of the materials to be used for crack preparation and repair, including the following minimum information:

   i. Material specifications.
   ii. Product data sheets with test data.
   iii. Material safety data sheets.

iv. Pot life of the components to be used based on a sample size of 200 ml at 5 °C and 20 °C.

c) A certificate from the material supplier shall be submitted stating the material is suitable for the intended use in this Contract.

d) A list of the equipment and accessories to be used including the following minimum information:

i. The operating pressure of each component.
ii. The type of injection port and means of closure.

932.04.02 Return of Submissions

Two copies of each submission shall be returned marked as one of the following:

a) Stamped with the wording that allows for permission to construct.

In this case, work can commence upon receipt of the submission by the Contractor. A copy of the submission shall be available at the site prior to and during construction.

b) Stamped with the wording that allows for permission to construct as noted.

In this case, work can start upon receipt of the submission by the Contractor. The submission shall be updated as noted and shall have a stamp affixed that is signed by an Engineer stating the submission has been revised according to the noted comments. A copy of the stamped updated submission shall be available at the site prior to and during construction.

c) Showing only required changes.

In this case, the submission shall be updated as required and the submission process repeated.

932.05 MATERIALS

932.05.01 Grout

932.05.01.01 General

Material used for crack injection shall be polyurethane resins for active cracks and epoxy resins for passive cracks.

Polyurethane and epoxy grout shall prevent the penetration of water and shall have sufficient flowability to fill the crack at least 80% of the depth of the crack using the proposed equipment and method of repair at the ambient and substrate temperatures existing at the time of grouting.

932.05.01.02 Epoxy Resin

Epoxy resin shall be moisture insensitive and 100% solids.

932.05.01.03 Polyurethane Resin

Polyurethane resin shall be 100% solids.

932.05.02 Joint Sealing Compounds

932.05.02.01 Hot-Poured Rubberized Joint Sealing Compound

The hot-poured rubberized joint sealing compound shall be according to OPSS 1212.

932.05.02.02 Cold-Applied Joint Sealing Compound

Cold-applied joint sealing compound shall be according to ASTM C920, Type S, Grade NS, Class 25, Use TM. Type M sealant shall be used where the depth of a chase exceeds 15 mm or the manufacturer's recommended depth for Type S sealant, whichever is less. Where the cold sealing compound is visible after completion of the work a grey colour material shall be used.

932.05.03 Water

Water shall be according to OPSS 1302.

932.06 EQUIPMENT

932.06.01 Gauges

In addition to the calibrated gauges required for use with the pumps and with the injection hose, additional gauges shall be available on site to replace those that malfunction.

Certificates of calibration, from an organization accredited by the Standards Council of Canada shall be supplied for each gauge certifying that the gauges are capable of measuring the pressure within a tolerance of $\pm$ 5 kPa.

932.06.02 Pumps

Equipment used for pressure injection shall be suitable for the intended use and compatible with the grout.

Pumps shall be positive displacement type and shall be capable of delivering a minimum of two litres of grout per minute.

Pumps shall be capable of developing a maximum regulated operating pressure at least equal to twice the effective pressure.

Pumps shall be equipped with a calibrated gauge and shall be capable of accurately maintaining an effective operating pressure of 50 kPa or less.

Plural component pumps shall be used when multicomponent solution grouts are used.

Hand cartridge pumps shall not be used unless the volume of crack repair is less than one litre of resin for 100 m^2 of gross repair area.

932.06.03 Mixers

932.06.03.01 Static In-Line Mixers

Static in-line mixers shall produce a homogeneous grout and shall be sized to accommodate the minimum and maximum anticipated flow rates.

Static mixers shall have the manufacturer’s plate attached showing the following mixer information:

a) Size.

b) Type.

c) Maximum operating pressure.

932.06.03.02 Agitating Mixer

Agitating mixers shall have a power driven paddle mixing head and produce a homogeneous component.

The speed of the mixers shall be variable to a maximum of 500 rpm.

932.06.04 Injection Hoses

Injection hoses shall have a rated working pressure equal to or greater than the maximum pump operating pressure and shall be equipped with a calibrated gauge at the injection port end.

932.06.05 Injection Ports

Injection ports shall be removable or non-metallic insert type units. The pressure capacity of the injection ports shall be at least equal to the maximum operating pressure of the pump. All injection ports shall be equipped with a shut-off valve or other mechanical means of closure under pressure.

Surface mounted injection ports shall not be used.

932.06.06 Air Compressor

Compressed air shall be free from oil and water when tested according to ASTM D4285.

932.06.07 Drills

Drilling of the injection holes shall be performed using a rotary percussion or rotary diamond type drill.

Percussion drilling equipment shall not be used for drilling holes greater than 26 mm diameter and holes within 150 mm of any edge of concrete.

Only holes 26 mm or less in diameter shall be drilled within 50 mm of any free edge of concrete.

932.06.08 Routing Equipment

Routing equipment shall be any of the following:

a) Concrete router.

b) Hand-held grinding wheel or a multi-bladed cut-off saw equipped with abrasive or diamond blades.

c) Multi-bladed floor saw cutting equipment equipped with diamond blades.

932.07 CONSTRUCTION

932.07.01 General

Installation of all accessories and material shall be according to the manufacturer's recommendations and as specified in the submitted work plan.

Work shall only proceed when the temperature of the concrete is 5 °C or greater.

932.07.02 Access

Adequate access shall be provided to facilitate:

a) Performance of work.

b) Inspection and measurement of the work by the Contract Administrator.

932.07.03 Crack Identification

Prior to commencement of the work, the cracks requiring repair, as identified by the Contract Administrator, shall be numbered, physically marked as to their extent, and measured in the presence of the Contract Administrator.

This information shall be recorded and a copy submitted to the Contract Administrator.

932.07.04 Crack Injection

932.07.04.01 Drilling for Injection Ports

Injection holes shall be drilled, on each side of the crack, at a 45° angle to the surface of the concrete. The holes shall be located such that they intersect the crack section at approximately the midpoint and they shall extend through the crack section. The holes shall be sized to accommodate the injection ports. The spacing of the holes shall not exceed the depth of the crack or 200 mm, and the holes shall be alternated from one side of the crack to the other.

Prior to installation of the injection ports each hole shall be individually cleaned of all deleterious material by an air-water blast to completely remove all drill cuttings from the hole.

Injection ports shall be inserted into the holes and sealed. The inserted end of the injection port shall not extend beyond the point at which the drilled hole intersects the crack.

932.07.04.02 Cleaning and Flushing

After the injection ports have been inserted, cracks shall be flushed with an air-water mixture or an alternating water and air flush to remove all deleterious material prior to the injection of grout. The flushing material shall be injected through the injection port and continued until it exudes from the adjacent injection port and the crack is thoroughly cleaned. This flushing shall proceed from one end of the crack to the other.

A final flush shall be made with air only to remove all of the free water.

932.07.04.03 Surface Preparation and Sealing

Surface opening of the cracks shall be sealed prior to injection.

The surface of the concrete shall be mechanically cleaned for a distance of 25 mm each side of the crack sections to prepare a clean substrate for bonding of the surface sealing compound. The surface preparation and sealing shall be as recommended by the manufacturer of the surface sealing material.

The surface sealing material shall completely confine the injection grout to the crack section with only the injection ports providing access. The surface sealing material shall withstand the maximum injection pressure without developing leakage along the crack section.

Surface sealing of passive cracks shall not commence until at least one hour after the final air flush.

932.07.04.04 Injection of Grout

932.07.04.04.01 General

Injection of grout shall proceed from the injection port at the lowest elevation of the crack and continue upwards along the crack on an injection port to injection port basis without interruption to the other end of the crack. The injection nozzle shall not be moved to the adjacent injection port until grout is showing at the next higher adjacent injection port or refusal criteria is developed.

While under pressure, each injection port shall be sealed immediately after completion of injection at that injection port.

When a maximum operating pressure greater than 3 MPa is required to inject the grout, the injection operation shall cease until the Contractor determines why this operating pressure is required.

932.07.04.04.02 Monitoring

The volume of grout used within each five metres of crack length shall be recorded. The pump gauge pressure shall be recorded every 10 minutes. The volume of grout and pump pressure shall be related to the crack location.

The records shall indicate crack location and number, injection port spacing and confirmation of grout showing or refusal. A copy of the recorded information shall be submitted to the Contract Administrator at the end of each Day.

932.07.04.04.03 Effective Pressure

When calculating the effective pressure, the head losses shall be determined prior to commencement of injection.

Head losses shall be determined in the presence of the Contract Administrator by performing a pressure flow test, through the equipment, for each equipment configuration used.

932.07.04.04.04 Ratio Test

Plural component injection equipment proportioning shall be verified in the presence of the Contract Administrator by measuring the volume output of material in the pressure lines at least once for each two hours of operation.

When deviation from the manufacturer's specified proportioning ratio exceeds 5%, immediate adjustment or replacement of the equipment is required.

932.07.04.04.05 Pot Life Determination

Prior to commencing the grouting operation, a sample shall be taken from the material containers on site and manually proportioned to the specified component ratio in the presence of the Contract Administrator. The total sample size shall be 200 ml, and the same size container shall be used for each sample taken.

The temperature of the material at the time of mixing and the pot life of the mixed material shall be recorded.

The proportions of materials and pot life shall conform to those specified in the original submissions.

An additional sample shall be taken from the end of the injection hose and a further pot life determination performed.

During grouting material samples shall be taken on a frequency of at least one per hour of operation and the pot life recorded.

Deviation from the proportions and pot life specified shall result in immediate discontinuance of use of the material.

All records shall be submitted to the Contract Administrator at the end of each working day.

932.07.04.05 Surface Finishing

Surface finishing shall not proceed until the curing period, as specified by the material supplier, has elapsed. Surface finishing shall consist of removal of the injection ports and the surface sealant flush with the original concrete surface. Core holes and holes left after the removal of injection ports shall be filled with a cement-based non-shrink grout after the surface sealant has been removed.

Where the crack is not completely filled to the injection surface, the crack shall be filled with a compatible material acceptable to the Contract Administrator. The material shall be applied according to the manufacturer's recommendations.

932.07.04.06 Coring

A 75 mm diameter test core shall be taken for each completed ten-metre increment of injected crack for the full depth of the crack, within 1½ to 2 hours after injection, at locations specified by the Contract Administrator. The ten-metre increment is the length of a continuous crack or a cumulative measurement of cracks of lesser length. The cores shall be submitted to the Contract Administrator. Similar coring shall be done to check remedial work.

932.07.04.07 Filling of Core Holes

Following the extraction of cores all slurry and other debris shall be removed from the core holes. The holes shall be blasted with compressed air and filled with non-shrink grout flush with the surface of the concrete.

Surface preparation, mixing, installation, and curing shall be according to the manufacturer's recommendations.

932.07.05 Routing and Sealing Cracks

Cracks shall be routed to create a chase and then filled with a sealant.

The depth to width ratio of the chase shall be 1H:1V with the crack located within the middle third of the chase. The width of the chase shall be 15 mm $\pm$ 5 mm.

The chase shall be abrasive blast cleaned according to OPSS 929. Abrasive blast cleaned areas shall have the subsequent treatment applied within 36 hours or shall be reblasted.

Immediately prior to placing the bond breaker, the chase shall be blasted with compressed air to remove all dust, dirt, and loose material.

A bond breaker compatible with the joint sealing compound and concrete shall be placed at the bottom of the chase.

Joint sealing compound shall be placed in the chase flush with the adjacent concrete surface unless it is subjected to vehicular traffic, in which case, it shall be recessed 2 mm $\pm$ 1 mm.

Hot-poured rubberized joint sealing compounds shall only be used on horizontal surfaces. Cold-applied joint sealing compounds shall only be used on vertical surfaces or on horizontal surfaces that are not to be waterproofed. Cold-applied joint sealing compound shall be installed according to the manufacturer's recommendations. Hot-poured rubberized joint sealing compound shall be installed according to OPSS 920.

932.07.06 Remedial Action

The failure of the test cores to meet the requirements specified in the Quality Assurance section shall be sufficient cause for immediate review and adjustment of the method of injection. The ten-metre increments represented by the failed test cores shall be repaired such that at least 80% of the crack depth is filled. The method of repair shall be submitted to the Contract Administrator prior to the commencement of the work.

932.07.07 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

932.08 QUALITY ASSURANCE

932.08.01 General

When the repair operation is complete, the Contract Administrator shall inspect the work to determine if the completed work contains defects.

932.08.02 Crack Injection

The 75 mm diameter test cores shall be examined for the percentage of the crack depth filled.

932.08.03 Ratio Test

The proportioning ratio of the injection material shall not deviate more than 5% from the manufacturer's specified proportioning ratio stated in the work plan.

932.08.04 Pot Life

The proportion of material and pot life shall not deviate from that specified by the manufacturer in the work plan.

932.08.05 Acceptance or Rejection

The Contract Administrator shall accept or reject material on the basis of the ratio testing and pot life determination results.

Crack injection shall be accepted or rejected on the basis of the percentage of crack depth filled as determined by evaluating the test core taken in each ten-metre increment of length.

Rejection of the ten-metre increment of crack shall be applied during the entire grouting operation.

Where 90% or more of the crack depth is filled in the test core, the ten-metre increment of crack length represented by the core shall be accepted.

Where 80 to 89% of the crack depth is filled in the test core, the work shall be accepted and a payment adjustment shall be applied to the ten-metre increment length of crack represented by that core.

Where less than 80% of the crack depth is filled in the test core, the ten-metre increment of crack length represented by the core shall be rejected.

932.09 MEASUREMENT FOR PAYMENT

932.09.01 Actual Measurement

932.09.01.01 Crack Injection

Measurement of crack injection shall be by length in metres of the accepted injected cracks. The total length shall be the sum of individual increments represented by the accepted test cores taken within each increment. Cracks filled to less than 80% of the crack depth shall not be measured for payment.

932.09.01.02 Routing and Sealing

Measurement of routing and sealing shall be by length in metres.

932.10 BASIS OF PAYMENT

932.10.01 Crack Injection - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

There shall be 100% payment of the Contract price where 90% or more of the crack depth is filled.

There shall be no payment where less than 80% of the crack depth is filled.

There shall be a payment adjustment of the unit Contract price for each ten-metre increment of crack filled to between 80% and 89% of the crack depth.

$$Pa = [100 - (89-D) \times 2] \div 100$$

Where: Pa = payment adjustment factor
D = percentage of the crack depth filled, rounded to the nearest 0.1%.

and: $89 \geq D \geq 80$

932.10.02 Routing and Sealing-Hot-Poured Rubberized Joint Sealing Compound-Item
Routing and Sealing-Cold-Applied Joint Sealing Compound-Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Appendix 932-A, November 2020
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

CONSTRUCTION SPECIFICATION FOR MECHANICALLY STABILIZED EARTH

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940-A **Commentary**

940.01 SCOPE

This specification covers the requirements for the design and construction of Mechanically Stabilized Earth (MSE) walls and steep slopes.

Additional requirements for MSE precast concrete facing elements shall be as specified in the Contract Documents.

940.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

940.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

940.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 501 Compacting

Ontario Ministry of Transportation Publications

MTO Designated Sources of Materials (DSM)

CSA Standards

S6-14 Canadian Highway Bridge Design Code (CHBDC)

940.03 DEFINITIONS

For the purposes of this specification the following definitions apply:

Alignment Elements means components specified by the manufacturer that are constructed on the foundation for MSE to facilitate placing of the facing elements to the correct lines and grades, such as concrete levelling pads and soldier piles.

Accepted Product Drawings means the documentation for an MSE that has been submitted by the manufacturer and accepted by the Ministry for listing in the DSM.

Backfill for MSE means the material specified by the manufacturer as part of the engineered materials comprising the backfill for the MSE.

Constructed Height means the vertical distance between the foundation for MSE and the top of the currently placed and compacted backfill for MSE, measured at the point of the design height.

Corrective Work means work carried out by the Contractor to repair deficiencies identified by the Owner during the MSE warranty period.

Design Checking Engineer means the Engineer retained by the Contractor who checks the original design and working drawings.

Design Engineer means the Engineer retained by the Contractor who produces the original design and working drawings.

Design Height means the maximum difference in elevation between the foundation for MSE and the corresponding top of backfill for MSE, over the full length or perimeter of the MSE.

External Stability means stability against deep-seated failure of the foundation for MSE, including adequate bearing capacity at specified settlements of the foundation.

Facing Elements means components specified by the manufacturer that delineate the front face of the MSE and to which reinforcing elements may be attached, such as precast concrete panels, split-face concrete blocks, and geo-synthetic panels.

Foundation for MSE means the base on which the MSE is constructed, such as excavation to a specified elevation and construction of a granular pad.

Internal Stability means stability against failure of the engineered materials comprising the MSE, including adequate resistance against excessive elongation, breakage and pullout of the reinforcing elements.

Manufacturer means the firm who supplies the design and proprietary components, and who specifies the backfill and other materials, for the MSE.

Manufacturer's Certificate of Conformance means a letter issued by an Engineer confirming that the fabrication and required testing has been carried out on a component or product in conformance with the Contract Documents.

Manufacturer's Representative means an individual with continuous full-time employment with the manufacturer for a period of at least three years, and who is knowledgeable in the design and construction of the MSE.

Mechanically Stabilized Earth (MSE), (formerly known as Retained Soil System, RSS) means a proprietary system listed on the DSM used to retain horizontal loads for applications such as true and false abutment structures, retaining walls and steep slopes; or, to retain vertical loads for applications such as embankments over soft ground.

MSE Superintendent means the Contractor's authorized representative in responsible charge of the construction of the MSE.

Obstruction means any part of the work and any existing condition within the Working Area that affects the design, construction and performance of the MSE, such as structures, catch basins and manholes, drainage pipes and sewers, and utilities.

Performance Tolerance – Local means the joint gap between any two constructed facing elements, measured at any point along the joint between the facing elements and perpendicular to the line of the joint.

Performance Tolerance – Global means the vector distance between any point on the constructed MSE and the corresponding point on the theoretical MSE surface as defined in the Contract Documents.

Placing Tolerances means tolerances specified by the manufacturer on the placing of the MSE components and backfill for MSE to ensure compliance of the constructed MSE with the performance tolerances.

Reinforcing Elements means components specified by the manufacturer that are placed within the backfill for MSE and connected to the facing elements to mechanically stabilize the backfill for MSE, such as metal tie strips, metal grids and geo-synthetic grids,

Structure means any bridge, culvert, tunnel, retaining wall, overhead sign, high mast light pole, wharf, dock, or any part thereof.

940.04 DESIGN AND SUBMISSION REQUIREMENTS

940.04.01 Design

940.04.01.01 General

The Contractor shall be responsible for the design of the MSE and for ensuring the MSE as designed is compatible with the Work.

The geometric requirements of the MSE, such as lines and grades of the facing elements and typical cross-sections, shall be as specified in the Contract Drawings.

The foundation for MSE shall be as specified in the Contract Documents.

940.04.01.02 MSE Selection

An MSE shall be selected from the DSM listing with ‘A’ (Accepted) status, and that meets the application, performance and appearance requirements for that MSE, as specified in the Contract Documents.

When there is more than one MSE included in the same tender item number for payment, all MSE for the tender item shall be selected from the same DSM listing, including type and colour of facing elements.

All MSE that abut an existing structure, or a structure to be constructed as part of the Work, and that have the same performance and appearance requirements, shall be selected from the same DSM listing, including type and colour of facing elements.

940.04.01.03 Performance Tolerances

Performance tolerances for the MSE shall be according to Table 1.

940.04.01.04 Obstructions

Design details of the MSE shall be included on the Working Drawings for all obstructions shown in the Contract Drawings.

Where an obstruction is shown in the Contract Drawings but not located to sufficient accuracy for the design of the MSE, the obstruction shall be located in the field to sufficient accuracy as required to design the MSE.

940.04.01.05 Foundation Report

A Foundation Investigation Report, that describes the subsurface conditions at the MSE site, is available as specified in the Contract Documents.

The Owner warrants the data in the foundation investigation report, except that interpretations of the data and opinions expressed in the foundation investigation report are not warranted.

940.04.02 Submissions

940.04.02.01 Working Drawings

At least two weeks prior to commencement of construction of the MSE, three sets of Working Drawings shall be submitted to the Contract Administrator for information purposes. A separate submission of Working Drawings shall be made for each MSE in the Contract. All submissions shall bear the seal and signature of the design Engineer and the design checking Engineer.

The MSE superintendent shall have a copy of the Working Drawings on site at all times during the construction of the MSE.

940.04.02.02 Working Drawing Requirements

Working Drawings shall include at least the following:

a) Statement from the manufacturer confirming the experience and expertise of the design Engineer and design checking Engineer to provide design services for the manufacturer's MSE;

b) All design, fabrication and construction drawings and specifications for the MSE;

c) Location and value of the design height of the MSE;

d) Defined lines and grades, type, and quantity in cubic metres of the backfill for MSE;

e) Details at obstructions, and connections to other structures, where shown in the Contract Drawings;

f) Statement of bearing resistance required by the MSE foundation according to CSA S6;

g) Statement of satisfactory internal and external stability; and

h) Placing tolerances for the MSE.

940.04.02.03 MSE Superintendent

At least two weeks prior to commencement of construction of the MSE, the name(s) of the MSE superintendent responsible for each MSE in the Contract shall be submitted in writing to the Contract Administrator.

During construction of an MSE, the MSE superintendent shall not change without written permission from the Contract Administrator. A proposal for a change in the MSE superintendent shall be submitted at least one week prior to the actual change in MSE superintendent.

940.04.02.04 Manufacturer's Representative

At least two weeks prior to commencement of construction of the MSE, the name(s) of the manufacturer's representative shall be submitted in writing to the Contract Administrator.

At least 48 hours written advance notice shall be provided to the Contract Administrator prior to each visit to the site by the manufacturer's representative. The advance notice shall include the dates and locations the manufacturer's representative will be on site.

940.04.02.05 Manufacturer's Certificates of Conformance

Upon completion of each MSE element(s), a certificate of conformance sealed and signed by an Engineer employed or retained by the Contractor shall be submitted to the Contract Administrator.

940.04.02.06 Milestone Inspection

For each MSE, a milestone inspection report shall be submitted to the Contract Administrator following an interim inspection by an Engineer employed or retained by the Contractor at each of the following milestones completed, and prior to commencement of subsequent operations on that MSE:

a) Layout and marking of all lines and grades needed to construct the MSE; and construction of the alignment elements, where applicable;

b) Delivery and storage on site of facing elements and reinforcing elements, where applicable; and

c) Installation of the facing elements; placement and compaction of the backfill for MSE; and installation of the reinforcing elements, where applicable.

For MSE where the design height is greater than 5.0 m, a series of written permissions signed by an Engineer employed or retained by the Contractor to proceed for milestone c) shall be submitted corresponding to the constructed height of the MSE at 5.0 m, 10.0 m, and 15.0 m, as applicable, up to and including the design height.

The milestone inspection submissions in no way supersede the inspection and testing intervals required for the construction of the MSE, as specified in the Working Drawings.

940.04.02.07 MSE Warranty

A warranty shall be submitted to the Owner to address all deficiencies identified by the Owner related to the performance of the MSE for a period of 36 months from the date of the Substantial Performance date.

940.04.02.08 Repair Procedures for Corrective Work During the Warranty Period

Three copies of repair procedures for corrective work shall be submitted to the Contract Administrator for information purposes only at least two weeks prior to commencement of any corrective work at an MSE required during the warranty period.

The repair procedures shall include a description of the cause and fully detail the corrective work required to correct the deficiencies identified by the Owner.

The repair procedures shall bear the seal and signature of an Engineer, and be signed by the manufacturer's representative.

940.05 MATERIALS

940.05.01 General

All materials for the selected MSE shall be according to the approved product drawings for that MSE.

940.06 EQUIPMENT

940.06.01 Restriction on Skid-Steer Vehicles

Skid-steer vehicles shall not be permitted on any area where the depth of backfill for MSE over installed reinforcing elements is less than 0.5 m.

940.07 CONSTRUCTION

940.07.01 General

The MSE shall be constructed according to the Working Drawings and this specification.

Construction of the MSE shall not begin until all applicable certificates of conformance for the foundation of the MSE have been submitted to the Contract Administrator.

940.07.02 MSE Superintendent

The construction of an MSE shall be scheduled such that it is at all times under the responsible charge of an MSE superintendent who has been advised on site by the manufacturer's representative as to the required procedures for the construction of that MSE, for the specified operations and time periods.

940.07.03 Manufacturer's Representative

The manufacturer's representative shall be on site at commencement and as necessary to advise the MSE superintendent as to the construction procedures of the MSE, for the following operations:

a) Layout of the MSE; and construction of the alignment elements, where applicable;

b) Installation of the facing elements; and

c) Placement and compaction of the backfill for MSE; and installation of the reinforcing elements, where applicable.

Whenever there is a change in the MSE superintendent during construction of an MSE, the manufacturer's representative shall return to the site to advise the new MSE superintendent for the same operations.

940.07.04 Backfill for MSE

Backfill for MSE shall be placed within the lines and grades shown on the Working Drawings. All backfill for MSE shall be compacted according to OPSS 501.

Unless otherwise shown in the Contract Drawings, backfill for MSE shall not be placed against an adjacent concrete structure that is part of the work until the concrete in that structure has obtained at least 70% of the compressive strength specified in the Contract Documents.

940.07.05 Management of Excess Materials

Management of excess materials shall be according to the Contract Documents.

940.08 QUALITY ASSURANCE

940.08.01 Warranty Inspections

Throughout the warranty period the Owner will carry out warranty inspections of the MSE for deficiencies according to Table 2. The Owner will notify the Contractor as to the date and time of the inspection(s) and the Contractor may, at his discretion, be present during the inspection(s).

Within two weeks following a warranty inspection the Owner will notify the Contractor in writing of all deficiencies that require corrective work.

940.08.02 Warranty Period Corrective Work

All deficiencies shall be repaired according to the repair procedures for corrective work. All corrective work shall be done within the MSE warranty period, unless prevented by seasonal shutdown, in which case the corrective work shall be done prior to June 30 of the following year.

At least one week prior to commencement of any corrective work, written notice of commencement of work shall be submitted to the Contract Administrator or the Owner.

Access to the corrective work shall be provided for inspection by the Owner when requested.

940.08.03 Acceptance Criteria at End of the MSE Warranty Period

The Owner will accept the MSE at the end of the MSE warranty period if none of the deficiencies listed in Table 2 are found during the warranty inspections. The MSE shall not be accepted until all deficiencies have been repaired by corrective work.

940.09 MEASUREMENT FOR PAYMENT

940.09.01 Actual Measurement

940.09.01.01 Backfill for Mechanically Stabilized Earth, Ultra Lightweight
Backfill for Mechanically Stabilized Earth, Lightweight
Backfill for Mechanically Stabilized Earth, High Performance
Backfill for Mechanically Stabilized Earth, Medium Performance
Backfill for Mechanically Stabilized Earth, Low Performance

Measurement shall be of the mass in tonnes of the material placed within the theoretical lines and grades shown in the stamped Working Drawings. The method of determining the mass shall be as specified in the Contract Documents.

940.10 BASIS OF PAYMENT

940.10.01 Mechanically Stabilized Earth, True Abutment - Item
Mechanically Stabilized Earth, False Abutment - Item
Mechanically Stabilized Earth, Wall/Slope, High Performance - Item
Mechanically Stabilized Earth, Wall/Slope, Medium Performance - Item
Mechanically Stabilized Earth, Wall/Slope, Low Performance - Item
Mechanically Stabilized Earth with Finishing Cap, Wall/Slope, High Performance - Item
Mechanically Stabilized Earth with Finishing Cap, Wall/Slope, Medium Performance - Item
Mechanically Stabilized Earth, Roadbase Embankment - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment and Material to do the work, including all costs associated with having the manufacturer's representative on site.

Payment for construction of the foundation for MSE shall be made under the appropriate tender items in the Contract.

No payment shall be made for corrective work, including investigation of deficiencies, design of repairs, site access, traffic staging and removal of existing work, except where the corrective work is required as a result other than an act or fault of the Contractor.

940.10.02 Backfill for Mechanically Stabilized Earth, Ultra Lightweight - Item
Backfill for Mechanically Stabilized Earth, Lightweight - Item
Backfill for Mechanically Stabilized Earth, High Performance - Item
Backfill for Mechanically Stabilized Earth, Medium Performance - Item
Backfill for Mechanically Stabilized Earth, Low Performance - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment and Material to do the work.

When the Contract does not contain a separate tender item for backfill for MSE, the contract price for the MSE contract items in which the backfill for MSE is incorporated shall include full compensation for all labour, Equipment and Material required to place and compact the backfill for MSE.

TABLE 1
Performance Tolerances for MSE

Performance Requirement	**Performance Tolerance (mm)**	
	Local	**Global**
Abutments	Joint Gap $\pm$ 5 (Note 1)	$\leq$ 20
High	Joint Gap $\pm$ 10 (Note 1)	$\leq$ 30
Medium	N/A	$\leq$ 50
Low	N/A	$\leq$ 100
Notes: 1. Joint Gap shall be as specified on the working drawings.		

TABLE 2
MSE Deficiencies

Number	**Description of Deficiency**
1	Performance tolerance exceeds tolerances given in Table 1.
2	Damaged facing elements and damaged alignment elements, where applicable.
3	Dead and dying vegetative elements that are an integral part of the MSE.

Appendix 940-A, November 2019
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should determine if any of the following are required and, if so, specify them in the Contract Documents.

- Show geometric requirements of the MSE, such as lines and grades of the facing elements and typical cross-sections. (940.04.01.01)

- Foundation Investigation Report that describes the subsurface conditions at the MSE site. (940.04.01.05)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

CONSTRUCTION SPECIFICATION FOR MECHANICALLY STABILIZED EARTH PRECAST CONCRETE ELEMENTS

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941-A **Commentary**

941.01 SCOPE

This specification covers the requirements for materials, quality assurance testing and acceptance criteria for Mechanically Stabilized Earth (MSE) precast concrete elements.

941.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

941.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

941.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 905 Steel Reinforcement for Concrete
OPSS 911 Coating Structural Steel Systems
OPSS 919 Formwork and Falsework
OPSS 929 Abrasive Blast Cleaning - Concrete Construction

Ontario Provincial Standard Specifications, Material

OPSS 1301 Cementing Materials
OPSS 1302 Water
OPSS 1303 Admixtures For Concrete
OPSS 1306 Burlap
OPSS 1350 Concrete - Materials and Production
OPSS 1440 Steel Reinforcement for Concrete

Ontario Ministry of Transportation Publications

MTO Laboratory Testing Manual:
LS-407 Method of Test for Compressive Strength of Moulded Cylinders
LS-426 Method of Test for Compressive Strength of High Performance Concrete Cylinders
LS-412 Method of Test for Scaling Resistance of Concrete Surfaces Exposed to De-icing Chemicals

Designated Sources for Materials (DSM)
Structural Manual

MTO Form:
PH-CC-322 Concrete Construction Report

CSA Standards

A23.2-9C Compressive Strength of Cylindrical Concrete Specimens*
A23.2-19C Obtaining and Testing Drilled Cores for Compressive Strength Testing*
A23.4-16 Precast Concrete Material and Construction

* [Part of A23.1-19/A23.2-19 - Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete]

ASTM International

C 457/457M-16 Microscopical Determination of Parameters of the Air-Void System in Hardened Concrete
C 1202-17 Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration

941.03 DEFINITIONS

For the purposes of this specification the following definitions apply:

Bughole means a small regular or irregular cavity resulting from entrapment of air bubbles in the surface of formed concrete during placement and consolidation.

Cold Joint means a joint or discontinuity resulting from a delay in placement of sufficient duration to preclude intermingling and bonding of the concrete.

Element Type means an element defined by function and common shape, including facing elements, finishing caps, corner elements and other element types.

Facing Elements means components specified by the manufacturer that delineate the front face of the MSE and to which reinforcing elements may be attached, such as precast concrete panels, split-face concrete blocks, and geo-synthetic panels.

Honeycombing means a rough and stony concrete surface with voids where the mortar did not fill the spaces between the coarse aggregate particles.

Lot means all precast elements from one structure, from a single MSE supplier, including facing elements, finishing caps, corner elements and other element types. The maximum Lot size shall be 500 m^2 of vertical face of the MSE.

Precast Element means an individual precast section. "Precast element" is used interchangebly with "element".

Repair Proposal means a submission when repairs to the precast elements are required.

Mechanically Stabilized Earth (MSE) as defined in OPSS 940.

Segregation means visible separation of the mortar and coarse aggregate particles in the concrete, resulting in concrete that is not uniform in appearance or proportions.

Structure means any bridge, culvert, tunnel, retaining wall, overhead sign, high mast light pole, wharf, dock, or guideway, or any part thereof, or other reinforced concrete component designed to carry loads, including high mast pole footings and sign support footings.

941.04 DESIGN AND SUBMISSION REQUIREMENTS

941.04.01 Submission Requirements

941.04.01.01 Concrete Mix Design

The concrete mix design shall be submitted according to OPSS 1350.

Subject to the Owner's approval, self-consolidating concrete (SCC) may be used.

941.04.01.02 Precast Plant Certification

The certificate verifying compliance of the precast plant with the certification requirements of the Canadian Standards Association (CSA) or the Canadian Precast Concrete Quality Assurance Certification Program (CPCQA) shall be submitted to the Contract Administrator with the concrete mix design Form A submission.

Copies of precast plant certification audit reports of CPCQA or CSA, or both as applicable, and related documentation shall be submitted to the Owner upon request.

Documentation verifying certification of the concrete production facility by the Ready Mixed Concrete Association of Ontario shall be submitted, if concrete is supplied by a ready-mixed concrete supplier, with the concrete mix design Form A submission.

941.04.01.03 Manufacturer's Certificate of Conformance and Precast Report

A Manufacturer's Certificate of Conformance and a precast report shall be submitted to the Contract Administrator for each shipment of elements at least five Business Days prior to shipping from the precasting plant.

The precast report shall contain the following information:

a) List of elements in the shipment, including their ID number, lot number, and description.

b) Temperature records for formwork and steel at the time of concrete placement.

c) Temperature control records, including location of thermocouple wires and graphical plots verifying that neither the maximum temperature limit or maximum allowable temperature difference have been exceeded.

d) Record of inspection of moist curing.

e) Summary of material test results for plastic concrete: air content, slump, and concrete temperature.

f) Documentation confirming that all repairable defects have been identified, evaluated, and repaired as detailed in the Repair of Defects and Deficiencies Repairable by Standard Methods clause.

g) Covermeter and dimensional check report.

h) Sampling records for compressive strength, air void system, rapid chloride permeability and scaling resistance.

941.05 MATERIALS

941.05.01 Burlap

Burlap shall be according to OPSS 1306.

941.05.02 Concrete

Materials for concrete shall be according to the Materials section of OPSS 1350 with the following additions and amendments:

a) Compressive strength shall be as specified in the Contract Documents.

b) The air void system in hardened concrete when tested according to ASTM 457/457M shall be:

   i. Air Content: 3.0% minimum
   ii. Spacing Factor: 0.200 mm maximum

c) Rapid chloride permeability of concrete containing silica fume at 28 to 32 Days shall be equal to or less than 1,000 coulombs and rapid chloride permeability of all other concrete at 28 Days to 32 Days shall be equal to or less than 2,500 coulombs.

d) Superplasticizer may be added to the mix at time of batching for all types of concrete.

e) Loss of surface mass due to scaling when tested in accordance with LS-412 shall not exceed 0.8 kg/m².

941.05.03 Concrete Sealers

Concrete sealers shall be according to OPSS 1350.

941.05.04 Formwork

All formwork shall be according to OPSS 919 and CAN/CSA A23.4. Formwork shall be fabricated to meet the dimensional tolerances and finishes required in the Contract Documents.

941.05.05 Hardware

All hardware shall be non-corroding or be galvanized according to OPSS 911.

941.05.06 Proprietary Patching Materials

Proprietary patching materials shall be according to OPSS 1350.

941.05.07 Steel Reinforcement

Steel reinforcement shall be according to OPSS 1440.

941.05.08 Water

Water used for curing, fog-misting, steam curing of concrete, including presoaking of material for moist curing, shall be according to OPSS 1302.

941.06 EQUIPMENT

941.06.01 Temperature Monitoring and Recording System

The temperature monitoring and recording system shall provide unalterable records of temperature during the recording period and shall be submitted in the precast report. Prior to use on the Contract, the temperature monitoring and recording system shall be confirmed by the Owner, in writing, to be acceptable.

Thermocouples and associated instrumentation shall have an accuracy of ± 1.5 °C, shall record temperatures at time intervals not exceeding 15 minutes and shall display the temperature.

941.07 CONSTRUCTION

941.07.01 General

The Contract Administrator shall be notified in writing at least seven Days prior to commencement of fabrication.

Each concrete element shall be identified with a unique number and the date of casting within 24 hours of stripping forms. The information marked on the elements shall be marked on any surface of the element except the exposed front face. Markings shall be stencilled, using indelible ink or paint.

941.07.02 Precast Plant Certification

Elements shall be fabricated at a precast plant certified by CSA or by CPCQA under the category Group B, Bridges, as subcategory B1 (Precast Bridge Products).

941.07.03 Steel Reinforcement

The placement of steel reinforcement shall be according to OPSS 905.

Under no circumstance shall reinforcement be inserted into plastic concrete.

941.07.04 Production of Concrete

Production of concrete shall be according to, requirements for temperature control, mixing time and mixing rate, and delivery in OPSS 1350.

941.07.05 Placing of Concrete

941.07.05.01 General

The method of transporting, placing and consolidating the concrete shall be such as to prevent segregation.

Concrete shall be deposited within 0.5 m of the top of the reinforcement and 1.5 m horizontally of its final position.

Concrete shall be placed at a steady rate, such that a monolithic concrete is obtained without the formation of cold joints or pour lines.

941.07.05.02 Concrete Placing Restrictions

All surfaces against which concrete is to be placed shall be free of standing water.

All debris shall be removed from the area where concrete is to be placed.

Any surface against which concrete is placed, including any existing concrete, steel reinforcement, structural steel, forms, or other surfaces shall be at a minimum temperature of 5 °C immediately prior to commencement of placing concrete. The average temperature of the formwork, steel reinforcement or any other material against which concrete is to be placed shall not exceed 30.0 °C, with no individual temperature exceeding 35.0 °C.

Temperature measurements shall be taken no more than ten minutes prior to concrete placement and shall be taken for the same element on which the concrete temperature is measured as per the Control of Temperature clause. Temperature measurements shall be made with a contact thermometer with an accuracy of ± 1 °C. Temperature measurements shall be recorded and submitted in the precast report.

941.07.06 Consolidation

Internal or external vibrators or both shall be used to thoroughly consolidate concrete.

Vibration shall not be used to make the concrete flow or to spread the concrete more than 1.5 m from the point of deposit.

941.07.07 Concrete Finishing

Finishing of the concrete surface shall be done immediately following placement.

No material shall be applied to the concrete surface or the finishing tools to aid in the finishing.

941.07.08 Control of Temperature

941.07.08.01 General

All necessary actions shall be taken to maintain temperatures within the specified limits. During the moist curing and protection periods, the following temperature requirements shall be met:

a) The concrete temperature shall not exceed 70 °C.

b) The concrete temperature shall not fall below 10 °C before the end of moist curing.

941.07.08.02 Temperature Monitoring and Records

The concrete and air temperature during the curing period shall be monitored and recorded.

The concrete temperature shall be measured and recorded on one element per day with the thermocouple installed to measure the maximum internal temperature typically located at mid-depth within the element at the maximum section thickness.

Thermocouples for monitoring air temperature shall measure air temperature adjacent to the element.

Recording of the concrete and air temperature shall begin at the start of the concrete placing operation and continue until the moist curing is complete. The temperatures shall be recorded automatically at intervals not exceeding 15 minutes. The dataloggers shall continue to operate until the end of the monitoring period.

The Contract Administrator and any other Owner’s representatives shall be provided access to verify temperature readings.

941.07.09 Curing

941.07.09.01 General

Concrete elements shall be moist cured for four Days. Concrete elements containing silica fume shall be moist cured for seven Days.

Moist curing of exposed surfaces shall commence immediately after concrete placement.

For elements with exposed surfaces that have architectural finish, moist curing shall be applied within 30 minutes of concrete placement.

941.07.09.02 Moist Curing

Moist curing shall be sufficient to keep all surfaces of the precast element in a continuously wet condition, with no dry areas, by applying one or a combination of the following methods:

a) Curing with burlap and water

b) Curing with water mist

c) Immersion

Records of moist curing shall be maintained and submitted according to the Precast Report clause. The records shall provide evidence that curing is being confirmed and is satisfactory. As a minimum, records of moist curing shall include the identification of the person checking the moist curing and the time that it was confirmed.

941.07.09.03 Curing with Burlap and Water

Burlap shall be pre-soaked by immersing it in water for a period of at least 24 hours immediately prior to placing. Two layers of burlap shall be applied to the surface of the concrete. Burlap strips shall overlap 150 mm and shall be held in place without marring the surface of the concrete.

The burlap shall be maintained in a continuously wet condition throughout the curing period by means of a soaker hose. The soaker hose shall be turned on as soon as possible, when running water will not cause damage to the concrete surface. The burlap shall be covered with a layer of moisture vapour barrier within three hours of placing of the concrete, in a manner that shall prevent deformation of the surface of the concrete.

Air flow in the space between the burlap and the element shall be prevented.

Water shall not be allowed to drip, flow or puddle on the concrete surface until the concrete has hardened sufficiently to resist damage.

941.07.10 Surface Finish

941.07.10.01 General

Concrete surfaces shall not be treated with cement slurry or paste.

Surface defects and deficiencies with dimensions as shown in Table 1 are repairable by standard methods according to Table 1.

A repair proposal shall be submitted to the Contract Administrator to repair surface defects and deficiencies with dimensions greater than those listed in Table 1.

941.07.10.02 Exposed Surfaces

The appearance of the concrete and repairs shall be uniform in colour, pattern, and texture when viewed from a distance of 5 m.

Repair material, including proprietary patching materials, shall be selected to achieve uniformity of colour and appearance. This requirement shall apply to all repair methods specified in Table 1. Uniformity of colour and appearance is subject to approval of the Contract Administrator.

All projections, such as fins and bulges, and all blemishes, such as stains and rust marks, shall be removed.

941.07.10.02 Surface Tolerances

Formed and unformed surfaces shall be such that, when tested with a 3 m long straight edge placed anywhere in any direction on the surface, there shall be no gap greater than 3 mm between the bottom of the straight edge and the surface of the concrete.

941.07.11 Sampling and Testing of Plastic Concrete

Sampling and testing of the plastic concrete for slump, air content, and temperature shall be according to OPSS 1350. The results of these tests shall be recorded and submitted in the precast report. The minimum frequency of testing shall be as follows:

a) For concrete supplied by an external concrete supplier and delivered by a ready-mix truck, once for each of the first three trucks, until satisfactory control is established, and then once every third truck.

b) For batches of concrete produced at the precast plant and transported by a ready-mix truck, once for each of the first three trucks, until satisfactory control is established, and then once every third truck.

c) For batches of concrete produced at the precast plant, and not delivered by a truck, once for each of the first five batches of concrete, until satisfactory control is established, and then once every fifth batch.

Satisfactory control is established when three or five consecutive tests of concrete, as specified above, are within the specified requirements, without adjustments. If any adjustments are required or conducted, testing shall continue until three or five consecutive tests, as specified above, meet the requirements with no adjustments. Satisfactory control shall be established each Day or when there is a break in production longer than 1.5 hours.

Testing of plastic concrete shall be carried out as close as possible to the location of discharge of concrete into the formwork.

Sampling and testing of slump, air content, and temperature of plastic concrete shall be carried out by a person holding either of the following certifications:

a) CCIL Certified Concrete Testing Technician, or

b) ACI Concrete Field Testing Technician, Grade 1

The person shall have a valid original card issued by the certifying agency in his or her possession at all times.

941.07.12 Stripping Strength

Prior to stripping the formwork, it shall be demonstrated that the stripping strength specified in the Contract Documents has been achieved. The Contractor, when requested by the Owner, shall participate in standard cylinder correlation strength testing programs conducted by the Owner.

941.07.13 Concrete Cover Measurement

The Contract Administrator shall be notified in writing when the elements are ready for the concrete covermeter survey.

The Contract Administrator shall carry out a covermeter survey on the concrete elements prior to installation. Measurements shall be carried out on multiple concrete elements randomly selected by the Contract Administrator, at multiple locations on the elements. A total of 30 measurements per lot shall be carried out.

941.07.14 Dimensional Tolerances

All elements shall meet the dimensional tolerance requirements of CSA 23.4 unless otherwise specified in the Contract Documents. For dimensional tolerances not specified, the maximum allowable dimensional variation shall be 1:800 or $\pm$ 5 mm, whichever is greater.

Unless otherwise specified in the Contract Documents, the tolerance for concrete cover over reinforcement of a precast concrete element shall be - 5 mm / + 15 mm.

941.07.15 Repair of Defects and Deficiencies Repairable by Standard Methods

Any individual element having one or more defects and deficiencies identified in Table 1 shall be repaired according to the repair method specified. Such repairs do not require proposals or Owner approval.

Where more than one of the defects or deficiencies listed in Table 1, excluding bugholes, is located in the same area in the element, a repair proposal shall be submitted to the Contract Administrator for Owner approval.

941.07.16 Material Sampling for Acceptance Testing

941.07.16.01 Sampling of Steel Reinforcement

When requested by the Contract Administrator, samples of steel reinforcement shall be provided to the Owner according to OPSS 905.

941.07.16.02 Sampling of Cementing Materials, Water and Admixtures

When requested by the Owner, sampling of all cementing materials, water, and admixtures, shall be in accordance with OPSS 1301, 1302 and 1303 respectively.

941.07.16.03 Sampling of Hardened Concrete for Acceptance Testing

941.07.16.03.01 General

Test specimens shall consist of cylinders cast from plastic concrete for determination of compressive strength and cores and slabs removed from precast concrete facing elements for determination of air void system parameters of hardened concrete and rapid chloride permeability. Test specimens shall be delivered to the designated laboratory for testing by the Owner.

Cores and slabs shall be removed at the plant or on site when the element is between seven to ten Days of age, and prior to application of any sealer. Cores and slabs shall be removed in the presence of the Contract Administrator or Owner's representative.

For panels less than 2 m in vertical height, the Contractor shall supply one additional panel of the most common size for each lot for sampling of cores and slabs. The concrete facing element from which the test specimens shall be taken shall be randomly selected from the lot by the Contract Administrator.

For panels greater than 2 m in vertical height, the cores and slabs shall be removed from portions of the concrete elements to be installed below grade. The concrete element to be tested shall be randomly selected by the Contract Administrator and the locations of cores and slabs shall be determined by the Contract Administrator. The core and slab removal locations shall be repaired according to the Coring clause.

At the discretion of the Owner, an additional sample shall be provided of a different element type for acceptance testing.

941.07.16.03.02 Notification

A list of elements and their identification numbers shall be submitted to the Contract Administrator within 24 hours of the completion of a lot.

909.07.16.03.02 Cylinders for 28-Day Compressive Strength Testing

Sets of cylinders, 100 mm diameter and 200 mm long, shall be cast for 28-Day compressive strength testing by the Owner.

At the Contractors discretion one set of referee cylinders may be cast for each lot.

All concrete test cylinders shall be cast in new, single-use moulds conforming to the requirements of CSA A23.2-1D and made of plastic, with a lid. The lids shall be chemically and physically compatible with the concrete and shall provide watertight closure for the moulds.

Concrete test cylinders shall be cast, cured, and transported to the designated laboratory according to CSA A23.2-3C with the exception that cylinders shall be cured with the girder prior to delivery to the laboratory. Cylinders shall be delivered to the laboratory for demoulding.

Test information shall be recorded on MTO form PH-CC 322. A copy of the form shall be submitted with each set of the concrete cylinders along with a transmittal form and the Form A of the concrete mix design for the facing elements.

941.07.16.03.03 Coring

One set of cores shall be obtained from each lot for quality assurance testing as directed by the Contract Administrator. A set of cores shall consist of six 100 mm diameter and 200 mm long cores or, if the panel is less than 200 mm thick, the full depth of the panel such that the core has a length to diameter ratio of at least 1.5.

The element from which the cores and samples are taken shall be clearly labelled and shall be retained until Contract Completion.

Coring shall be carried out according to CSA A23.2-14C. Cores shall not contain reinforcement or other embedded material. A covermeter capable of detecting the type(s) of reinforcing materials in the element shall be used to establish the location of reinforcement and other embedded material prior to coring.

The contract number, and lot number, and element identification shall be marked legibly on each core with durable ink. Each core shall be placed in a plastic bag, sealed to prevent loss of moisture and placed into clear polyethylene security bags supplied by the Owner when instructed by the Contract Administrator. The specimens shall be accompanied by a transmittal form and the Form A of the concrete mix design for the precast element. At this point, the Contract Administrator shall take possession of, and assume responsibility for the samples. The Contract Administrator or his representative may apply security seals.

The core holes shall be filled, within three Days, with concrete or a proprietary patching material according to OPSS 1350. The patching material shall be comparable to the surrounding concrete in terms of strength and permeability. The patching material shall be mixed, handled, and cured according to the manufacturer's instructions. Immediately prior to filling, the inside surface of each core hole shall be cleaned and mechanically roughened and made free of water. The patch shall be finished flush with the surface of the surrounding concrete. All excess material shall be removed from the surface of the concrete.

941.07.16.03.04 Salt Scaling Samples

Two 300 mm by 300 mm samples shall be removed from the element by the Contractor, as directed by the Contract Administrator, for testing of salt scaling resistance by the Owner according to LS-412. Two additional 300 mm by 300 mm samples shall be removed from the element by the Contractor and retained by the Owner for referee testing. Dimensions shall be within - 5 mm / + 10 mm of specified values. Slabs shall be trimmed to a thickness of 75 mm to 100 mm. The contract number, lot number, element identification shall be marked legibly on each slab with durable ink. Each slab shall be placed in a plastic bag, sealed to prevent loss of moisture and placed into clear polyethylene security bags supplied by the Owner when instructed by the Contract Administrator. The specimens shall be accompanied by a transmittal form and the Form A of the concrete mix design for the precast element. At this point, the Contract Administrator shall take possession of, and assume responsibility for the samples. The Contract Administrator or his representative may apply security seals.

For facing elements with textured architectural finish, the salt scaling test shall be conducted on the back face of the facing element.

941.07.17 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

941.08 QUALITY ASSURANCE

941.08.01 General

The acceptance of elements shall be according to the requirements of this specification, including satisfactory completion of all repairs, if applicable. Elements not meeting the requirements of the Contract Documents shall be deemed unacceptable and shall not be included in the Work.

Acceptance for compressive strength, air void system parameters, rapid chloride permeability, salt scaling resistance and concrete cover shall be on a lot basis. The lot size shall represent all precast elements from one structure, from a single MSE supplier, with a maximum lot size of 500 m^2 of vertical face of the MSE. The lot size shall be confirmed by the Contract Administrator and remain consistent for the duration of the Contract.

Unacceptable lots shall be rejected and replaced.

941.08.03 Acceptance of Concrete Compressive Strength

Compressive strength of cylinders, for acceptance, shall be determined according to LS-426 for concrete with silica fume and high strength concrete, and according to LS-407 for all other concrete.

941.08.03.01 Basis of Acceptance

28-Day compressive strength of a lot shall be considered acceptable when it meets all of the following:

a) The average of the set of three cylinder compressive strengths shall be equal to or greater than the specified 28-Day compressive strength.

b) No individual cylinder test shall be more than 4.0 MPa below the specified 28-Day compressive strength.

Unacceptable lots shall be rejected and replaced.

Test results shall be forwarded to the Contractor as they become available.

941.08.03.02 Referee Testing of Compressive Strength

If the Contractor has submitted a set of referee cylinders, an individual test result may be questioned by the Contractor within five Business Days of receiving the test result. The Contractor shall notify the Owner of his intention to referee test.

The lot shall be re-evaluated as based on the test result from the referee compressive strength cylinders representing the lot and the referee test result shall replace the original test result. The referee test result shall be binding.

941.08.03 Acceptance of Air Void System in Hardened Concrete

Testing of air void system shall be according to ASTM 457/457M. One half of the sample shall be tested to determine the acceptability of the lot. The other half of the sample shall be retained by the Owner for audit purposes.

Test results shall be forwarded to the Contractor as they become available.

For a lot to be considered acceptable, the sample shall have a minimum air content of 3.0% and a spacing factor of 0.200 mm or less. Acceptable lots shall be subject to full payment.

Lots with samples with a spacing factor between 0.200 mm and 0.250 mm shall be considered unacceptable. Unacceptable lots shall be rejected and replaced, except where the Owner permits an unacceptable lot to remain in place. When the Owner permits an unacceptable lot to remain in place it shall be subject to a payment adjustment, calculated according to the Basis of Payment section.

Lots with samples with air content less than 3.0%, a spacing factor more than 0.250 mm or both shall be rejected and replaced.

941.08.03.01 Referee Testing of Air Void System in Hardened Concrete

Referee testing of air void system parameters may only be invoked by the Contractor within five Business Days of receiving the test result.

When referee testing is invoked, all core samples representing a lot shall be referee tested and the acceptance test results discarded. The lot referee test results shall replace the acceptance test result in the acceptance requirements of this specification.

Referee testing shall be carried out on the same half of the core sample that was tested for acceptance. Cores shall be tested according to ASTM 457/457M. Referee test results shall be forwarded to the Contractor, as they become available.

941.08.04 Acceptance of Rapid Chloride Permeability

Acceptance of rapid chloride permeability shall be based on the result obtained on the core representing the lot.

One core per lot shall be tested according to ASTM C1202. Acceptance testing shall be carried out at 28 to 32 Days. Two samples 50 mm long shall be cut from the core representing a lot, tested and averaged to determine the acceptance of the lot. Another core shall be retained for referee testing.

Lots with rapid chloride permeability between 2,500 coulombs and 3,500 coulombs shall be considered unacceptable. Unacceptable lots shall be rejected and replaced, except where the Owner permits an unacceptable lot to remain in place. When the Owner permits an unacceptable lot to remain in place it shall be subject to a payment adjustment, calculated according to the Basis of Payment section.

Lots with rapid chloride permeability results exceeding 3,500 coulombs shall be rejected and replaced.

For concrete lots containing silica fume, rapid chloride permeability between 1,000 coulombs and 2,000 coulombs shall be considered unacceptable. Unacceptable lots shall be rejected and replaced, except where the Owner permits an unacceptable lot to remain in place. When the Owner permits an unacceptable lot to remain in place it shall be subject to a payment adjustment, calculated according to the Basis of Payment section.

Lots containing silica fume with rapid chloride permeability results exceeding 2,000 coulombs shall be rejected and replaced.

Test results shall be forwarded to the Contractor as they become available.

941.08.04.01 Referee Testing of Rapid Chloride Permeability

Referee testing of rapid chloride permeability may only be invoked by the Contractor within five Business Days of receipt of the acceptance test result.

Referee testing shall be carried out on two 50 mm samples obtained from the reserved core representing the lot for which referee testing was invoked, and the results shall be averaged to obtain the test result for the lot.

The referee laboratory shall be designated by the Owner based on the applicable roster and cores shall be tested by that laboratory.

Referee test results shall be forwarded to the Contractor as they become available.

Referee testing of rapid chloride permeability testing for all concrete shall be carried out according to ASTM C1202.

When the referee result is greater than the acceptance test result or no more than 500 coulombs below the acceptance test result, the acceptance test result is then confirmed and shall remain valid. When the referee test result for the lot is more than 500 coulombs below the acceptance test result, the acceptance test result is then not confirmed, and the referee test result shall replace the acceptance test result in the acceptance requirements of this specification.

When the referee result confirms the acceptance test result, the Contractor shall be responsible for the cost of rapid chloride permeability referee testing. When the referee result does not confirm the acceptance test result, the Owner shall bear the cost.

941.08.05 Acceptance of Salt Scaling Resistance

Acceptance of salt scaling resistance shall be based on the average result obtained on two 300 mm × 300 mm samples per lot, tested according to LS-412, with the exception that conditioning and testing shall begin when samples are delivered to the quality assurance laboratory, regardless of age. For a lot to be considered acceptable, the average cumulative mass loss of the two samples after 50 freeze-thaw cycles shall not exceed 0.8 kg/m².

Lots with an average cumulative mass loss from 0.8 kg/m² to 1.2 kg/m² shall be considered unacceptable. Unacceptable lots shall be rejected and replaced, except where the Owner permits an unacceptable lot to remain in place. When the Owner permits an unacceptable lot to remain in place it shall be subject to a payment adjustment, calculated according to the Basis of Payment section.

Lots with an average cumulative mass loss exceeding 1.2 kg/m² shall be rejected and replaced.

941.08.05.01 Referee Testing of Salt Scaling Resistance

Referee testing of salt scaling resistance may only be invoked by the Contractor within five Business Days of receipt of the acceptance test result.

Referee testing for salt scaling resistance shall be carried out on the set of two referee slabs according to LS-412.

Referee test results shall be forwarded to the Contractor as they become available.

When the referee result is greater than the acceptance test result or no more than 0.1 kg/m² below the acceptance test result, the acceptance test result is then confirmed and shall remain valid. When the referee test result for the lot is more than 0.1 kg/m² below the acceptance test result, the acceptance test result is then not confirmed, and the referee test result shall replace the acceptance test result in the acceptance requirements of this specification.

The Contractor shall be responsible for the cost of salt scaling resistance referee testing.

941.08.06 Acceptance of Water, Admixtures, and Cementing Materials

Acceptance of water, admixtures, and cementing materials shall be according to OPSS 1350.

941.08.07 Acceptance of Concrete Temperature

Elements that meet the temperature requirements of this specification during production and the curing period are considered acceptable. Elements that do not meet one or more of the temperature requirements of this specification are considered unacceptable and shall be rejected and replaced.

941.08.08 Acceptance of Concrete Cover

Acceptance of concrete cover over reinforcing steel shall be based on the percentage of satisfactory measurements. The concrete cover over reinforcing steel shall be within - 5 mm / + 15 mm of the specified concrete cover. When 10.0% or more of the total number of measurements per lot is outside the specified limits, the lot shall be unacceptable.

Unacceptable lots shall be rejected and replaced.

The Contract Administrator shall provide the results of the covermeter survey to the Contractor.

941.08.09 Defects and Deficiencies

941.08.09.01 Defects and Deficiencies Repairable by Standard Methods

Any individual element having one or more of the defects and deficiencies listed in Table 1 shall be deemed unacceptable and the element shall be repaired according to Table 1.

When more than one of the defects or deficiencies listed in Table 1, excluding bugholes, is located in the same area in the element, the Contractor shall submit a repair proposal for acceptance according to the All Other Defects and Deficiencies clause.

941.08.09.02 Defects and Deficiencies Causing Rejection

An element having any one of the following defects and deficiencies shall be rejected:

a) If concrete temperature exceeds 70 °C at any time during the curing period.

b) If there is honeycombing, voids, cavities, spalls, delaminations, or cracks, in the concrete that exceed the conditions described in Table 1.

c) Broken corners.

d) If there is a crack that extends through to the opposite face.

e) If cover does not meet specified requirements except as indicated in the All Other Defects and Deficiencies clause.

If the element is deemed rejectable, the element shall not be incorporated into the Work.

941.08.09.03 All Other Defects and Deficiencies

A repair proposal signed and sealed by an Engineer shall be submitted to the Contract Administrator for acceptance, when,

a) An element has defects or deficiencies that are not identified as rejectable or included in Table 1 in the list of defects and deficiencies repairable by standard methods; or

b) More than one of the defects or deficiencies listed in Table 1, except for bugholes, are located in the same area in the element; or

c) Three occurrences of the same defect are present in the element; or

d) There is the presence of pour lines or cold joints; or

e) Unacceptable surface finish; or

f) Dimensional tolerances of the element do not meet the requirements of this specification; or

g) Failure to maintain moist curing has occurred.

The repair proposal shall include as a minimum:

a) Description of the element and identification of the defects or deficiencies.

b) A detailed repair plan including materials, method and equipment to be used.

c) Verification that the repair plan complies with the applicable standards for the type of work.

The following shall be made available to the Owner upon request:

a) All relevant supporting information, including material test results, field measurements and observations, production records, photographs, and structural analysis calculations, used for determining that the performance and function originally expected from the element shall be met.

b) Cause(s) of the defect and corrective action to be taken to prevent recurrence of the defect in future production, delivery or installation.

If the repair proposal is deemed acceptable, the element shall be repaired according to the proposal. Repairs shall not be carried out without the prior acceptance of the proposal by the Contract Administrator. If the repair proposal is deemed unacceptable, the element shall be rejected and replaced.

941.08.10 Assessment of Repairs

The Contract Administrator shall conduct a visual inspection and/or other measures as required, including requesting additional coring, covermeter surveys, or any other testing deemed necessary to assess the effectiveness of the repairs.

941.10.0 BASIS OF PAYMENT

941.10.01 Mechanically Stabilized Earth, True Abutment - Item
Mechanically Stabilized Earth, False Abutment - Item
Mechanically Stabilized Earth, Wall/Slope, High Performance - Item
Mechanically Stabilized Earth, Wall/Slope, Medium Performance - Item
Mechanically Stabilized Earth, Wall/Slope, Low Performance - Item
Mechanically Stabilized Earth with Finishing Cap, Wall/Slope, High Performance - Item
Mechanically Stabilized Earth with Finishing Cap, Wall/Slope, Medium Performance - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Corrective work, including investigation of defects and deficiencies, design of repairs, site access, traffic staging and removal of existing work, shall be at no additional cost to the Owner, except where the defects and deficiencies are not the fault of the Contractor.

Unacceptable lots shall be rejected and replaced at no additional cost to the Owner, except when the Contract Administrator permits an unacceptable lot to remain in the Work with a payment adjustment.

941.10.02 Payment Adjustment

941.10.02.01 Payment Adjustment for Air Void System in Hardened Concrete

Payment for unacceptable lot represented by the core shall be calculated according to the following:

Payment reduction for a lot = Lot quantity/tender quantity × Price × [(100 - P)/100]
Where:
Lot quantity = MSE front face area in a lot (m^2) (calculated based on plan dimension)
Tender quantity = MSE front face area in tender (m^2) (calculated based on plan dimension)
Price = Contract price for the MSE tender item
P = pay factor for the lot according to the spacing factor specified below:

Spacing Factor, mm	Pay Factor
0.200 to 0.220	90
0.220 to 0.240	80
0.240 to 0.250	70

941.10.02.02 Payment Adjustment for Rapid Chloride Permeability

The payment adjustment shall be calculated based on individual lots and applied as follows:

Payment adjustment = Lot quantity × (C-2500)/5
Where:
Payment adjustment = payment adjustment of a lot ($)
C = rapid chloride permeability of a lot (coulombs)
Lot quantity = volume of concrete in a lot (m^3) (calculated based on plan dimension)

The payment adjustment for concrete containing silica fume shall be calculated based on individual lots and applied as follows:

Payment adjustment = Lot quantity × (C-1000)/5
Where:
Payment adjustment = payment adjustment of a Lot ($)
C = rapid chloride permeability of a lot (coulombs)
Lot quantity = volume of concrete in a lot (m^3) (calculated based on plan dimension)

941.10.02.03 Payment Adjustment for Salt Scaling Resistance

Payment for unacceptable lot represented by the slab shall be calculated according to the following:

Payment reduction for a lot = Lot quantity/tender quantity × Price × [(100 - P)/100]
Where:
Lot quantity = MSE front face area in a lot (m^2) (calculated based on plan dimension)
Tender quantity = MSE front face area in tender (m^2) (calculated based on plan dimension)
Price = Contract price for the MSE tender item
P = pay factor for the lot according to the average cumulative mass loss specified below:

Average Cumulative Mass Loss, kg/m^2	Pay Factor
0.8 to 1.0	75
1.0 to 1.2	50

TABLE 1
Defects and Deficiencies Repairable by Standard Methods

Repairable Defects and Deficiencies	**Condition**	**Repair Method**
Bugholes	Bugholes with depth greater than 5 mm and all dimensions at the surface not exceeding 25 mm, or depth less than or equal to 5 mm and any dimension at the surface greater than 50 mm and not exceeding 100 mm.	a) Prior to filling bugholes, surfaces shall be blasted with high pressure water to remove any weak or loose material. b) Bugholes shall be filled with a proprietary patching material placed and cured according to the manufacturer's instructions.
Honeycombing, Voids, Cavities, Spalls, and Delaminations	Any area less than an equivalent area of 300 mm × 300 mm with no steel reinforcement exposed.	a) Square all sides of the repair area. b) Sawcut perimeter of removal area to a depth of 10 mm or to the depth of steel reinforcement, whichever is less. c) Remove all loose concrete using a chipping hammer or hand tools. d) Insert corrosion resistant wires and anchors. e) Abrasive blast clean all concrete surfaces to be patched according to OPSS 929. f) Remove all dust and loose material from the prepared surface by using compressed air. g) Moisten area to be repaired. h) Fill repair area with concrete or a proprietary product patching material. i) Cure concrete according to this specification. Cure proprietary patching material according to the manufacturer's recommendations.
Low Cover	Low cover readings between - 5 mm and - 10 mm of the specified cover.	The entire front face surface of the structure shall be sealed with a sealer acceptable by the Owner. Areas against which concrete is to be placed shall not be sealed.
Cracks	≤ 0.15 mm	Apply sealer acceptable to the Owner to the cracked areas. Where the total linear measurement of crack per m^2 is ≥ 5 m the entire front face surface of the structure shall be sealed.

Appendix 941-A, November 2019
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should determine if any of the following are required and, if so, specify them in the Contract Documents.

- If the Contract includes MSE system and MSE precast Concrete Elements in one tender item, consideration that Payment Adjustment be applied to the precast concrete elements portion of the item price only. (941.10.02)

- The designer shall consider specifying the use of premium reinforcement such as glass fibre reinforced polymer (GFRP) or stainless steel in situation where MSE wall is within the splash zone as defined MTO structural manual. (940.05.07, 941.07.03.)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

Note: The MUNI implemented in November 2019 replaces OPSS 942 COMMON, November 2009 with no technical content changes.

CONSTRUCTION SPECIFICATION FOR PRESTRESSED SOIL AND ROCK ANCHORS

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942.01 SCOPE

This specification covers the requirements for the design, installation, and testing of prestressed anchors in soil and rock.

942.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

942.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

942.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following specifications, standards, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 903	Deep Foundations
OPSS 904	Concrete Structures
OPSS 906	Structural Steel for Bridges

Ontario Provincial Standard Specifications, Material

OPSS 1301	Cementing Materials
OPSS 1302	Water
OPSS 1350	Concrete - Materials and Production
OPSS 1440	Steel Reinforcement for Concrete

CSA Standards

A23.1-04/A23.2-04	Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete
A283-06	Qualification Code for Concrete Testing Laboratories

G40.20-04/G40.21-04	General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steels

ASTM International

A 53/A 53M-07	Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
A 416/A 416M-06	Steel Strand, Uncoated Seven-Wire for Prestressed Concrete
A 500/A 500M-07	Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
A 722/A 722M-07	Uncoated High-Strength Steel Bars for Prestressing Concrete
D 1143/D 1143M-07	Standard Test Method for Deep Foundations Under Static Axial Compressive Load
D 1248-05	Polyethylene Plastics Extrusion Materials for Wire and Cable
D 1784-08	Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
D 3350-08	Polyethylene Plastics Pipe and Fittings Materials
D 4101-08	Polypropylene Injection and Extrusion Materials

International Organization for Standardization/International Electrotechnical Commission (ISO/IEC)

17025	General Requirements for the Competence of the Testing and Calibration Laboratories

American Petroleum Institute (API)

13A	Drilling Fluid Materials, 18th Edition, 01.10.06
RP 13B-1	Standard Procedure for Field Testing Water Based Drilling Fluids, 4th Edition

Post Tensioning Institute (PTI)

Recommendations for Prestressed Rock and Soil Anchors

942.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Alignment Load means a nominal minimum load applied to an anchor during testing to keep the testing equipment positioned correctly.

Anchor means a system used to transfer tensile loads to soil or rock that includes the prestressing steel, anchorage, corrosion protection, sheathings, spacers, centralizers, and grout.

Anchorage means the combined system of anchor head, bearing plate, trumpet, and anchorage corrosion protection that is used to transmit the prestressing force from the prestressing steel to the surface of the ground or the supported structure.

Anchor Head means the device by which the prestressing force is permanently transmitted from the prestressing steel to the bearing plate.

Apparent Free Length means the length of tendon or bar that is apparently not bonded to the surrounding ground or grout, as calculated from the elastic movement measured during the load test.

Bond Length means the length of the tendon that is bonded to the primary grout and capable of transmitting the applied tensile load to the surrounding soil or rock.

Centralizer means a device to support and position the tendon and sleeves in the drill hole throughout the bond length of the tendon so that a minimum grout cover is achieved.

Certificate of Conformance means a document issued by the Quality Verification Engineer confirming that the specified components of the Work are in General Conformance with the requirements of the Contract Documents.

Coupler means the method by which the prestressing force can be transmitted from one partial length of prestressing tendon to another.

Design Load means the anticipated final maximum effective load in the anchor after allowance for time-dependent losses or gains. The design load includes appropriate load factors to ensure that the overall structure has adequate capacity for its intended use.

Engineer means a professional engineer licensed by the Professional Engineers Ontario to practice in the Province of Ontario.

Free Stressing Length means the designed length of the tendon that is not bonded to the surrounding ground or grout during stressing.

Lift-Off means checking the load in the tendon at any specified time with the use of a hydraulic jack at the moment of lifting of the anchor head off the bearing plate.

Lock-Off Load means the prestressing force in an anchor immediately after transferring the load from the jack to the stressing anchorage.

Log Time Cycle means one rotation of a log cycle of a semilogarithmic plot for the purpose of recording the measurement of movement and time.

Permanent Anchor means a prestressed anchor intended for permanent use.

Performance Test means cyclic and incremental loading and unloading of an anchor, while recording the total movement of the pulling head in each cycle at each increment, including the residual movement at alignment load.

Post-Grouting means regrouting an anchor after the primary grout has set.

Pre-Production Test Anchor means an anchor installed and then loaded to verify the design parameters, prior to the installation of the production anchors.

Prestressing Steel means strands, a group of strands combined to form a tendon, or a high strength steel bar.

Primary Grout means Portland cement based grout that is injected into the anchor hole prior to or after the installation of the anchor tendon to provide for the force transfer to the surrounding ground along the bond length of the tendon.

Production Anchor means an anchor installed and loaded that forms part of the final foundation support system.

Production Test Anchor means an anchor installed and then loaded to verify the design parameters, prior to the installation of the production anchors.

Proof Test means incremental loading of an anchor and recording the total movement of the anchor at each increment.

Quality Verification Engineer means an Engineer retained by the Contractor qualified to provide the services specified in the Contract Documents.

Residual Movement means the non-recoverable movement of the pulling head measured at alignment load.

Temporary Anchor means a prestressed anchor intended for temporary use.

Test Load (TL) means the maximum load that the anchor is subjected during testing.

Total Movement means the total movement of the pulling head measured at maximum load in each cycle.

942.04 DESIGN AND SUBMISSION REQUIREMENTS

942.04.01 Design Requirements

942.04.01.01 General

Except for Owner designed anchors, the Contractor shall be responsible for the detailed design of the anchor, including the determination of the applied loads, design assumptions, and installation procedures. The Contractor shall also be responsible for the design of the anchor testing equipment and reaction system.

The anchors shall be designed to safely withstand the applied loads specified in the Pre-Production Test Anchor clause and fulfill the acceptance criteria specified in the Production Anchor clause and perform satisfactorily at the design load through the required service life.

The design assumptions shall accurately represent the subsurface conditions prevalent at the site.

Temporary anchors in a corrosive environment shall be designed as permanent anchors.

Except as specified in this specification, the anchors shall be designed according to the design recommendation of the Recommendations for Prestressed Rock and Soil Anchors publication.

942.04.02 Submission Requirements

942.04.02.01 Working Drawings

The Contractor shall submit 5 sets of Working Drawings to the Contract Administrator at least 3 weeks prior to the commencement of the work of prestressed rock and soil anchors, for information purposes only. Prior to making a submission, the seals and signatures of a design Engineer and a design-checking Engineer shall be affixed on the Working Drawings verifying that the drawings are consistent with the Contract Documents.

Where multi-discipline engineering work is depicted on the same Working Drawing and the design or design-checking Engineer or both are unable to seal and sign the Working Drawing for all aspects of the work, the drawing shall be sealed and signed by as many additional design and design-checking Engineers as necessary.

Information to be shown on the Working Drawings shall describe and illustrate the complete details of the anchor system, anchor testing equipment, and reaction system for the production anchors and, when specified in the Contract Documents, pre-production test anchors. This information shall include as a minimum:

a) Plans, Elevations, and Sections

   i. Anchor spacing.
   ii. Orientation.
   iii. Minimum total anchor length.
   iv. Free stressing length.
   v. Design load.

vi. A unique identification number for each anchor.
vii. Anchor components and details.

b) Installation

i. Construction methods.
ii. Work restrictions.
iii. Schedule.
iv. Sequence and coordination of work.
v. Monitoring.
vi. Type and number of tests
vii. Evaluation of test results.

c) Materials

i. Physical properties of monobar and multistrand anchors.
ii. Primary grout materials and mix proportions.
iii. Post grouting materials and mix proportions.
iv. Free stressing length materials and mix proportions.
v. Corrosion protection material physical and mechanical properties.

d) Anchor Hole Construction

i. Method of constructing the anchor holes and maintaining the stability of the holes during the anchor installation. The drilling equipment and materials including drill bit or auger diameter and lengths, casing diameter and lengths, and slurry material used to facilitate the construction of the anchor hole. The method of verifying the hole length shall also be identified.
ii. Details for assembling the anchor in the anchor hole.
iii. Method of placing and centring the anchor tendons, including the method used to maintain them in the centre of the hole over the design bond length.
iv. Bond zone primary grout placement. Grout mixing procedure and the method of installation, including grout pressures. The method to determine the surface of the hardened bond length grout shall be identified.
v. Bond zone post grout placement. Grout mixing procedure and the method of installation, including grout pressures.
vi. Free stressing zone grout placement. Grout mixing procedure and the method of installation, including grout pressures.
vii. Waterproofing of holes drilled in rock for permanent anchors. Details of water tightness tests, including setup, water pressure, method of applying pressure, details of consolidation, grouting, redrilling, and retesting.

e) Stressing Information

i. Anchor stressing schedule that includes the working loads and test loads.
ii. Anchor stressing equipment, and the method for testing the stressing of pre-production and production test anchors and production anchors. Details of the reaction system used to support the applied loads.
iii. Equipment, including the calibration records of the gauges and jacks, and procedure to monitor the applied loads and movements during anchor testing.
iv. Details of the reference system and equipment to monitor the movement.

f) All design assumptions, loads, parameters, and bond stresses used for pre-production and production test anchors and production anchors.

g) Testing records when testing has been done to determine bond stress.

h) Details of destressing and removal of temporary anchors.

942.04.02.02 Slurry

At least 14 Days prior to commencement of the work, the following information for the slurry shall be submitted to the Contract Administrator, for information purposes only:

a) The type, source, and physical and chemical properties of the bentonite or polymer.

b) The source of water.

c) Method of mixing slurry.

d) The water solids ratio and the mass and volumes of the constituent parts, including any chemical admixtures or physical treatment employed to produce slurry with the required physical properties.

e) Details of procedure to be used for monitoring the quality of the slurry.

f) A test report showing the properties of the slurry and certifying that the slurry meets the requirements of API 13A.

g) Method of disposal of the slurry.

942.04.02.03 Couplers

At least 14 Days prior to commencement of the work, a copy of the following shall be submitted to the Contract Administrator:

a) Manufacturer's catalogue giving the complete data on the coupler material and installation procedures.

b) Test reports from the manufacturer certifying strength and fatigue requirements.

942.04.02.04 Prestressing Steel

942.04.02.04.01 Mill Certificates

One copy of the mill test certificates, indicating that the steel meets the requirements of the Contract Documents, shall be submitted to the Contract Administrator at the time the prestressing steel is delivered to the job site.

Identification on the anchor tendon shall allow tracing of the prestressing steel to its heat or reel number.

Where mill test certificates originate from a mill outside Canada or the United States of America the Contractor shall have the information on the mill certificate verified by testing by a Canadian testing laboratory. The laboratory shall be accredited by the Standards Council of Canada as complying with the requirements of ISO/IEC 17025 for the specific tests or type of tests required by the material standard specified on the mill test certificate. The mill test certificates shall be stamped with the name of the Canadian testing laboratory and appropriate wording stating that the material is according to the Contract Documents. The stamp shall include the appropriate material specification number, testing date (i.e., yyyy-mm-dd), and signature of an authorized officer of the testing laboratory.

One copy of the stress-strain curves that are representative of the lots to be used shall be submitted to the Contract Administrator together with the mill certificates specified detailed in OPSS 1440.

942.04.02.04.02 Prestressing Steel Bond Capacity

If not available from the prestressing steel manufacturer, a prestressing strand bond capacity test shall be conducted on the strand according to Appendix A of the Recommendations for Prestressed Rock and Soil Anchors publication. The test information shall be submitted to the Contract Administrator prior to commencement of work.

942.04.02.05 Milestone Inspections

The Quality Verification Engineer shall witness the following interim inspections of the work:

a) Construction of anchor holes.

b) Anchor installation.

c) Primary grouting.

d) Post grouting.

e) Placement of slurry in free stressing length.

f) Anchorage installation.

g) Pre-production anchor testing.

h) Production anchor testing.

A written request for permission to proceed shall be submitted to the Contract Administrator prior to commencement of the successive operation.

942.05 MATERIALS

942.05.01 Permanent Anchors

942.05.01.01 General

Tendons shall be manufactured from steel bars or strand either in single or multiple element tendons.

The permanent anchors shall be Dywidag Threadbar Anchors, BBR Cona Multi-Strand Anchors, VSL Multi-Strand Anchors, or other approved equivalent anchors.

942.05.01.02 Anchorages

The components of the anchorage shall be capable of developing at least 100% of the guaranteed minimum ultimate capacity of the tendon or bar.

The anchor head shall be wedges for prestressing strands and anchor nuts for prestressing bars. The wedges shall be designed to uniformly engage the strand with no notch or pinching effects.

The bearing plate shall be fabricated from steel according to CSA G40.20/G40.21.

The trumpet shall be fabricated from steel pipe according to ASTM A 53M or tubing according to ASTM A 500M. The trumpet shall have a minimum wall thickness of 3 mm for diameters up to and including 100 mm and 5 mm for larger diameters. The joint between the trumpet and the bearing plate and the joint between the trumpet and sheath shall be watertight. The trumpet shall overlap the free stressing length corrosion protection by at least 100 mm. The trumpet shall be long enough to accommodate movements of the structure and the tendon during stressing and testing.

The anchorage covers shall completely encapsulate the anchor head with a watertight seal between the cover and the bearing plate.

942.05.01.03 Prestressing Steel

Prestressing steel shall be according to ASTM A 416M and ASTM A 722M.

Bars shall be high-tensile strength bars grade 1,030 MPa, 1,100 MPa, or 1,230 MPa.

Strand shall be seven-wire, uncoated, stress relieved and low relaxation strand grade 1,720 MPa, 1,760 MPa, or 1,860 MPa.

The strand and bar shall meet the bond capacity test specified in the Prestressing Steel Bond Capacity subsection.

942.05.01.04 Couplers

Couplers for bars shall be as specified by the supplier of the anchor and shall develop at least 100% of the guaranteed minimum ultimate strength of the tendon. Strand tendons shall not be coupled.

942.05.01.05 Cement

Cement shall be according to OPSS 1301 and shall be certified free of false set.

942.05.01.06 Water

Water shall be according to OPSS 1302.

942.05.01.07 Sheathing

Plastic sheathing shall be high density polyethylene according to ASTM D 1248, Type III, or polyvinyl chloride (PVC) according to ASTM D 1784, Class 13464-B or equal. The plastic sheathing shall be such that a bond of 5 MPa is developed when grout with a compressive strength of 30 MPa is used.

Hot melt extruded plastic tubing made from polyethylene according to ASTM D 3350 and ASTM D 1248 shall have an average minimum wall thickness of 1.5 mm. Hot melt extruded plastic tubing from polypropylene according to ASTM D 4101 shall have an average minimum wall thickness of 1.5 mm. Steel tubing or pipe shall have an average minimum wall thickness of 5.0 mm.

The materials for the sheathing accessories such as end caps, grouting caps, grout tubes, and sealing caps shall have properties equal to the plastic sheathing.

942.05.01.08 Heat Shrinkable Sleeves

Heat shrinkable sleeves shall be fabricated from a radiation cross-linked polyolefin tube internally coated with an adhesive sealant.

942.05.01.09 Grout Tubes

Grout tubes shall have an adequate inside diameter to enable the grout to be pumped to the bottom of the drill hole. They shall be able to withstand 1 MPa pressure.

Post-grout tubes shall be strong enough to withstand the post-grouting pressure.

942.05.01.10 Bond Breaker

The bond breaker shall be fabricated from plastic tube or pipe made from medium to high density polyethylene according to ASTM D 1248 or from polyvinyl chloride according to ASTM D 1784, Class 13464-B or equivalent, with a minimum wall thickness of 1 mm.

942.05.01.11 Centralizers and Spacers

Centralizers and spacers shall be steel or plastic.

942.05.01.12 Grout

The grout cube for high early strength grout shall be at least 20 MPa at 7 Days and 30 MPa at 28 Days. The type of cement used shall be suitable for the required use of the grout. Accelerators shall not be used. The grout shall bleed less than 2% when allowed to stand for 1 hour.

942.05.01.13 Corrosion Inhibiting Compound

The corrosion inhibiting compound placed in either the free stressing length or the anchorage area shall be an organic compound, grease, or wax with appropriate polar moisture displacing and self-healing properties and corrosion inhibiting additives. The compound shall permanently stay viscous and be chemically stable and non-reactive with the prestressing steel, sheathing material, and anchor grout.

942.05.01.14 Corrosion Protection

The anchor shall be provided with Class I, encapsulated tendon, double corrosion protection according to the Recommendation for Prestressed Rock and Soil Anchors publication.

The tendon shall be fully encased within a corrugated PVC sheathing that is, in turn, encased within a smooth PVC sheathing over the length of the free stressing zone and protected with grout having the 7- and 28-Day compressive strengths.

942.05.02 Temporary Anchors

The material for temporary anchors shall be the same as specified for the permanent anchors except the double protection system is not required.

942.05.03 Pre-Production Test Anchors

The material for the pre-production test anchors shall be the same as specified for the production anchor being evaluated.

942.05.04 Bentonite Cement Slurry

Bentonite and polymers shall meet the requirements of API 13A.

The bentonite cement slurry shall consist of a stable mixture of cement and a colloidal suspension of pulverized solids or polymers thoroughly mixed with water. The density, viscosity, sand content, and pH of the slurry while being used during excavation shall be according to API RP13B-1.

942.05.05 Concrete

Concrete shall be according to OPSS 1350 with a nominal 28-Day compressive strength of 30 MPa.

The slump shall be 150 to 180 mm.

942.06 EQUIPMENT

942.06.01 General

All equipment for the installation of the anchor, anchor stressing, anchor testing, and monitoring of the anchor test shall be suitable for the intended purposes and capable of working on the site under the prevailing access and clearance conditions.

The equipment used shall not cause damage to the anchor tendon, corrosion protection, or retained structural members.

The equipment used shall be in according to those listed in the required submissions.

942.06.02 Grouting Equipment

Mixers and pumps shall be of an adequate capacity and hoses shall be sized to allow continuous grouting of an individual anchor within one hour. A colloidal mixer with a gauge to measure the water shall be used.

942.06.03 Temporary Anchor Concrete Placement Equipment

Continuous flight augers shall be used for the placement of concrete for temporary anchors up to a maximum ratio of hole diameter to length of 1:35. Open hole concrete placement shall be limited to a minimum hole diameter of 600 mm and a maximum ratio of hole diameter to length of 1:15.

942.06.04 Anchor Testing Equipment

The rated capacity of the equipment shall not be exceeded when stressing the tendon to the maximum specified test load. The pump shall be capable of applying each load increment in less than 60 seconds.

The equipment shall permit the tendon to be stressed in increments so that the load in the tendon can be increased or decreased according to the test specifications and to allow the anchor to be lift-off tested to confirm the lock-off load.

Dial gauges shall have at least a 75 mm travel. Longer gauge stems or sufficient gauge blocks shall be provided to allow for greater travel where required. Gauges shall have precision of at least 0.02 mm.

Dial gauges shall permit the measurement of total tendon movement to the nearest 0.02 mm at every load increment. The gauge shall have sufficient travel to record the total anchor movement at test load without the need to reset at an interim point.

Jacks used for stressing tendons shall have a minimum ram extension of 150 mm.

Stressing equipment shall be calibrated within an accuracy of $\pm$ 2% immediately prior to use.

Current calibration curves bearing the seal and signature of an Engineer shall be provided for all gauges and jacks.

942.07 CONSTRUCTION

942.07.01 General

The Contractor shall be responsible for the material, fabrication, installation, testing, and monitoring of pre-production and production test anchors and production anchors.

In addition, for non-Owner designed anchors, the Contractor shall be responsible for the preparation of a soils report, the determination of design parameters, and the design of the anchors.

The anchor system shall be according to this specification and the Working Drawings.

Concrete placement according to the Concrete clause of the Caisson Piles subsection of OPSS 903 may be used for temporary anchors inclined a minimum of 30 degrees below the horizontal and having a minimum hole diameter of 450 mm.

942.07.02 Structural Steel

Structural steel components shall be fabricated according to OPSS 906.

942.07.03 Anchor Fabrication

Anchors shall be either shop or field fabricated according to the Working Drawings and schedules by personnel trained and qualified for this work.

Prestressing steel shall be cut with an abrasive saw or, when approved by the prestressing steel supplier, an oxyacetylene torch may be used.

All of the bond length shall be free of dirt, manufacturers' lubricants, corrosion-inhibiting coatings, or other deleterious substances that may significantly affect the grout-to-tendon bond or the service life of the anchor.

When encapsulated anchors are pregrouted, they shall be done on an inclined, rigid frame or bed by injecting the grout from the low end of the tendon.

Joints in the protection system shall be made watertight by use of an epoxy bonding agent.

942.07.04 Storage and Handling

Upon delivery, the fabricated anchors and the prestressing steel for fabrication of the tendons and all hardware shall be stored and handled in a manner that avoids mechanical damage, corrosion, and contamination with dirt or deleterious substances.

Handling of the tendons shall not cause mechanical damage or contamination to the prestressing steel, the corrosion protection, or the epoxy coating.

Rope or nylon slings shall be used.

Cement and additives for grout shall be stored under cover and protected against moisture.

Lifting of any pregrouted tendons shall not cause excessive bending that may debond the prestressing steel from the surrounding grout.

942.07.05 Corrosion Protection

942.07.05.01 Anchorage Protection

The corrosion protection of the tendon in the vicinity of the anchorage shall ensure proper protection.

All stressing anchorages permanently exposed to the atmosphere or that has a concrete cover less than 50 mm shall be covered with a corrosion inhibiting compound-filled or grout-filled cover.

On strand tendons, the trumpet shall be long enough to enable the tendon to make a transition from the diameter of the tendon along the free stressing length to the diameter of the tendon at the wedge plate without damaging the encapsulation.

The trumpet shall be completely filled with a corrosion inhibiting compound or grout. Compounds may be placed any time during construction. Grout shall be placed after the anchor has been tested and stressed to the lock-off load.

Corrosion inhibiting compound-filled trumpets shall have a permanent seal between the trumpet and the free stressing length corrosion protection.

Trumpets filled with grout shall have either a temporary seal between the trumpet and the free stressing length corrosion protection or the trumpet shall fit tightly over the free stressing length corrosion protection for a minimum of 0.3 m.

942.07.05.02 Free Stressing Length Protection

The tendon shall be fully encased within a corrugated PVC sheathing that is in turn encased within a smooth PVC sheathing over the length of the free stressing zone and protected with grout.

Corrosion protection of the free stressing length shall be provided by a sheath filled with a corrosion inhibiting compound or grout or a heat shrinkable tube internally coated with a mastic compound. The corrosion inhibiting compound shall completely coat the tendon elements, fill the void between them and the sheath, and fill the interstices between the wires of 7-wire strands. Provisions shall be made to retain the compound within the sheath.

The corrosion protective sheath surrounding the free stressing length of the tendon shall be long enough to extend into the trumpet but shall not come into contact with the stressing anchorage during testing.

For pregrouted encapsulations, a separate bond breaker shall be provided to prevent the tendon from bonding to the grout surrounding the free stressing length.

Fusion bonded epoxy may be used to provide an additional layer of protection to the prestressing steel.

942.07.05.03 Free Stressing Length and Bond Length Transition

The transition between the corrosion protection for the bonded and free stressing lengths shall be designed and fabricated to ensure continuous protection from corrosion.

The corrosion protection surrounding the free stressing length of the tendon shall not contact the bearing plate or anchor head.

942.07.05.04 Coupler Protection

On encapsulated bar tendons, the coupler and any exposed bar section next to it shall be covered with a corrosion proof compound or wax impregnated cloth tape. The coupler area shall be covered by a smooth plastic tube overlapping the adjacent sheathed tendon by at least 25 mm. The two joints shall be sealed each by a coated heat shrink sleeve of at least 150 mm length or approved equivalent. The corrosion proof compound shall completely fill the space inside the cover tube.

942.07.06 Construction of Anchor Holes

942.07.06.01 General

The anchor holes shall be constructed to the diameter, orientation, and length specified in the Contract Documents and detailed on the Working Drawings. A drilling method that establishes a stable anchor hole within the tolerances specified in the Contract Documents shall be used.

The sides and end of the completed anchor holes shall be maintained in a stable condition.

The anchor hole entry shall be located within 300 mm of its plan location. The deviation of the anchor hole entry angle from its inclination as specified the Contract Documents shall be no greater than $\pm$ 3 degrees.

Open anchor holes and drilled casings shall be cleaned upon completion of drilling.

Anchor holes open for longer than eight hours shall be recleaned prior to insertion of the tendon and primary grouting.

The following information shall be recorded for each anchor hole and submitted to the Contract Administrator:

a) Identification number.

b) Anchor hole diameter.

c) Anchor hole length.

d) Drilling procedure.

e) Soil, rock, and ground water conditions encountered.

f) Time required to drill the anchor hole.

g) Problems encountered.

942.07.06.02 Waterproofing Anchor Holes

Waterproofing of anchor holes shall be done when specified in the Contract Documents and according to the Working Drawings, procedures, and equipment.

If during the water tightness test, the leakage from an anchor hole over a ten-minute period exceeds 9.5 L, the anchor hole shall be consolidation grouted, redrilled, and retested.

Redrilling shall be done when the grout strength is considerably less than the strength of the surrounding rock.

942.07.07 Anchor Installation

The anchors shall be installed as specified in this specification and detailed on the Working Drawings.

Care shall be taken to ensure the sheathing, corrosion protection, and grout tubes are not damaged during installation of the anchors.

Damaged anchors that cannot be repaired to the satisfaction of the Contract Administrator shall be replaced.

Method of repair shall be submitted to the Contract Administrator for approval.

The prestressing steel in the tendon bond length shall be protected with a grout filled corrugated plastic encapsulation. Centralizers shall be used to ensure a grout cover of at least 12 mm over the encapsulation.

The centralizers shall be maintained in position during installation.

The centralizer shall support the tendon in the drill hole and position the tendon so a minimum grout cover of 12 mm is achieved. Centralizers used inside a sheath shall provide a nominal grout cover of 5 mm over the prestressing steel. All centralizers shall be designed to permit grout to flow freely around the tendon and up the drill hole.

The Contractor shall determine the number of centralizers required; however, one unit shall be placed within 1 m of the bottom of the hole and another at the bond length and free stressing length interface. The centralizers shall not interfere with the placement of grout.

Spacers shall be used in multiple element tendons to separate the strands or bars individually or into small groups.

942.07.08 Primary Grouting of Anchors

The grout shall be placed as specified in this specification and as detailed on the Working Drawings.

The grout shall entirely fill the annular space between the anchor and the borehole wall in the bond length.

Anchors shall be grouted as soon as practical after installation. The stressing tails of prestressing steel strands shall be aligned prior to initial set of the grout.

After grouting, the anchor shall remain undisturbed until the grout has reached the strength specified in the Contract Documents.

The following information shall be recorded for each anchor and submitted to the Contract Administrator:

a) Identification number.

b) Type of grout.

c) Grout pressure.

d) Volume of grout used.

e) Location of the top of the bond length grout.

942.07.09 Post-Grouting of Bond Length

When specified in the Contract Documents, post-grouting of the bond length shall be done according to the submitted procedures and equipment.

The information required to be recorded for primary grouting shall be recorded for post grouting.

Ground movement shall be monitored and, if excess movement is observed, the grouting shall be terminated and the situation reported to the Contract Administrator.

The Contract Administrator shall be notified prior to the commencement of post-grouting of both permanent and temporary anchors.

942.07.10 Placing of the Cement Bentonite Slurry in the Free-Stressing Length

The method of placing the cement bentonite slurry shall be as specified in this specification and as detailed on the Working Drawings.

The cement bentonite slurry for the free stressing length shall completely fill the annular space between the prestressing steel and the borehole wall and shall prevent any transfer of the anchor load to the free stressing zone.

942.07.11 Installation of Anchorage

The anchor bearing plate and the anchor head or nut shall be installed perpendicular to the tendon within $\pm$ 3 degrees and centred on the bearing plate, without bending or kinking of the prestressing steel elements. Wedge holes and wedges shall be free of rust, grout, and dirt. Special care shall be exercised to obtain the continuity of corrosion protection in the vicinity of the anchorage as described in the Corrosion Protection subsection. The stressing tail shall be cleaned and protected from damage until final testing and lock-off.

The tendon stressing tail shall be cut to its final length according to the tendon manufacturer's recommendations after the anchor is accepted by the Contract Administrator.

Anchorages permanently exposed to the atmosphere shall be covered with a corrosion inhibiting compound filled or grout filled cover

942.07.12 Testing

942.07.12.01 General

Testing shall be carried out as detailed on the Working Drawings and as specified in this specification.

The maximum anchor load shall not exceed 80% of the guaranteed minimum ultimate strength of the tendon.

Stressing shall not commence until the grout has reached its 28-Day strength.

Anchor tests shall be conducted at a time mutually acceptable to the Contractor and Contract Administrator. The Quality Verification Engineer shall witness the testing.

942.07.12.02 Reaction System

The reaction system shall be installed as detailed on the Working Drawings.

942.07.12.03 Reference System and Testing Equipment

The layout of the reference systems and testing equipment required for testing shall be as detailed on the Working Drawings and as specified in this specification.

All reference beams shall be independently supported with the support firmly embedded in the ground at a distance of not less than 2.5 m from the anchor. Reference beams and their supports shall be sufficiently rigid to support instrumentation and to prevent movement relative to the test anchor as a result of stressing or other construction activity during testing.

Dial gauges shall bear on the pulling head of the jack and their stems shall be co-axial with the tendon direction.

The jacks shall be secured with chains to provide adequate protection to personnel in the event of breakage of the anchor or stressing system.

942.07.12.04 Reference System Enclosures

Suitable enclosures shall be constructed to provide complete protection for personnel, equipment, and instruments from variations in the weather conditions and disturbances during the test program.

These provisions shall meet the approval of the Contract Administrator and include the following specific requirements:

a) The test enclosures shall be weatherproof and adequately lighted and have consistent and controllable heat in order to eliminate temperature variations.

b) The test enclosure shall be provided with a level dry floor.

c) A field office equipped with tables, chairs, heating, and lighting shall be provided adjacent to the test anchors.

942.07.12.05 Pre-Production Test Anchors

942.07.12.05.01 General

Pre-production tests shall be conducted to determine the bond stress when:

a) A bond stress is not specified in the Contract Documents.

b) A higher bond stress than specified in the Contract Documents is used in the design.

c) To establish the adequacy of other components of the anchor in advance of the production anchors.

For Contractor designed anchors, at least one pre-production test anchor shall be installed and tested in each significantly different ground condition.

For Owner designed anchors, the number of pre-production test anchors shall be as specified in the Contract Documents. The test anchor shall be constructed using the materials, methods, and procedures specified in this specification and as detailed on the Working Drawings.

Pre-production test anchors shall not be incorporated into the permanent or temporary work unless approved by the Contract Administrator.

942.07.12.05.02 Pre-Production Test Procedures and Measurements

The pre-production anchor test shall be carried out generally in accordance with the prevailing requirements of ASTM D 1143M superseded where applicable by the procedure specified in this specification.

When the pre-production test anchor is to be incorporated into the work, the load in the anchor shall be adjusted to lock-off load in the final cycle.

The pre-production test shall be conducted by cyclically and incrementally loading and unloading the anchor according to the schedule below or until the anchor fails.

AL, 0.25 DL, AL
AL, 0.25 DL, 0.50 DL, AL,
AL, 0.25 DL, 0.50 DL, 0.75 DL, AL
AL, 0.25 DL, 0.50 DL, 0.75 DL, 1.00 DL, AL,
AL, 0.25 DL, 0.50 DL, 0.75 DL, 1.00 DL, 1.25 DL, AL,
AL, 0.25 DL, 0.50 DL, 0.75 DL, 1.00 DL, 1.25 DL, 1.50 DL, AL
AL, 0.25 DL, 0.50 DL, 0.75 DL, 1.00 DL, 1.25 DL, 1.50 DL, 1.75 DL, AL,
AL, 0.25 DL, 0.50 DL, 0.75 DL, 1.00 DL, 1.25 DL, 1.50 DL, 1.75 DL, 2.00 DL*, AL
AL, 0.00 DL

Where:

AL = alignment load
DL = design load of anchor

* At 2.00 DL, the load shall be maintained for 24 hours.

Each load shall be maintained for a minimum of 15 minutes or until the rate of displacement is not greater than 0.25 mm per hour.

Vertical and horizontal movement of the reaction system and tendon elongation shall be recorded with respect to an independent fixed reference point. A record of the test enclosure temperature is also required.

During the load hold periods, the anchor load shall not be allowed to deviate from the test pressure by more than 0.35 MPa.

When required, repumping back to test load shall be done to compensate for small movements, hydraulic oil seepage, and changes in temperature of the hydraulic oil.

The load shall always be returned to the specified test load prior to taking the movement reading at the specified interval. The test load shall not be exceeded during the period of observation.

942.07.12.05.03 Removal of Pre-Production Test Anchors

The test anchors not approved to be incorporated into the work shall be removed flush with the surrounding ground and the test site restored to its pretest conditions.

The test anchorages shall not be removed until the Contract Administrator has given permission in writing to remove them.

942.07.12.06 Production Anchors

942.07.12.06.01 General

Every temporary and permanent anchor shall be tested according to the Proof Test - Permanent Anchors or Proof Test - Temporary Anchors clause, as appropriate.

942.07.12.06.02 Proof Test - Permanent Anchors

The following proof test shall be applied to the anchorages:

After preloading the anchor to 1.5 DL for 30 minutes, the proof test shall be conducted by incrementally loading and unloading the anchor according to the following schedule or until the anchorage fails, as determined by the Contract Administrator. The acceptance criteria apply to only the peak loading.

Loads shall be applied as follows:

0.25 DL, 1.00 DL, 1.50 DL, 1.00 DL, 0.25 DL

Where:
DL = specified working load of anchorage

At 1.50 DL, the load shall be maintained for a minimum of 30 minutes. Measurement shall be recorded according to the following time increment schedule.

0 min, 1 min, 2 min, 3 min, 6 min, 9 min, 12 min, 15 min, 18 min, 30 min.

If the acceptance criteria as specified herein are met, the anchorage shall be prestressed to 1.50 DL, then shall be locked-off at the transfer load of 1.10 DL.

If the acceptance criteria as specified herein are not met in the 30-minute period the test shall be extended as required, with readings at 30-minute increments, up to 180 minutes.

If the acceptance criteria as specified herein are not met, the provisions of the Unacceptable Stressing Results clause shall apply.

942.07.12.06.03 Proof Test - Temporary Anchors

The proof test shall be conducted by incrementally loading the anchor according to the following schedule:

AL, 0.25 DL, 0.50 DL, 0.75 DL, 1.00 DL, 1.20 DL, 1.33 DL, AL, and adjust to lock-off load

Where:
AL = alignment load
DL = specified working load of anchorage

At the test load of 1.33 DL, the load shall remain constant for 10 minutes and the total movement shall be recorded at 1, 2, 3, 4, 5, 6, and 10 minutes. If the difference between the total movements at 1 minute and 10 minutes exceeds 1 mm, the test load shall be maintained for an additional 50 minutes, and the movements readings shall be recorded at 20, 30, 40, 50, and 60 minutes. The anchor shall be returned to AL after holding the load at test load for 50 minutes and the residual movement recorded.

The hydraulic pressure during the load hold period shall not deviate by more than 0.35 MPa and the load shall be returned to the test load prior to taking the movement reading. The total movements at each load increment shall be recorded.

942.07.12.06.04 Lock-Off Procedure

After testing has been completed, the load in the tendon shall be such that, after seating losses (wedge seating), the specified lock-off load has been applied to the anchor tendon.

The magnitude of the lock-off load shall be 1.10 DL or as specified by the Contract Administrator and shall not exceed 70% of the ultimate load of the tendon or bar (F_{pu}).

The wedges shall be seated at a minimum load of 50% of F_{pu}. If the lock-off load is less than 50%, shims shall be used under the wedge plate and the wedges seated at 50% of F_{pu}. The shims shall then be removed to reduce the load in the tendon to the desired lock-off load. Bar tendons may be locked off at any load less than 70% of F_{pu}.

942.07.12.06.05 Lift-Off Tests

A minimum of three lift-off tests shall be conducted at each site. The location of the anchor to be tested and the time of test shall be as determined by the Quality Verification Engineer. The lift-off test shall not be performed until 48 hours has elapsed after transferring the lock-off load. The method of testing shall be as detailed on the Working Drawings.

The lift-off test shall be performed after transferring the load to the anchor and prior to removing the jack from its location. The lift-off load shall be determined by re-applying the load to the tendon or bar to lift off the wedge plate or anchor nut without unseating the wedges or turning the anchor nut.

942.07.12.07 Acceptance Criteria

An anchor shall be considered acceptable when all three of the following acceptance test criteria are satisfied:

a) The total creep movement at test load during the last log time cycle is less than 1.5 mm.

b) The apparent free stressing length based on the elastic movement at the test load is not less than 80% of the designed free stressing length.

c) The load measured during the lift-off test is within 10% of the designed lock-off load.

942.07.12.08 Unacceptable Stressing Results

For the anchorages that do not meet the acceptance criteria for the performance test or the proof test, the Contractor shall submit one of the following alternatives as a proposal to the Contract Administrator for approval:

a) Abandon the deficient anchor and install a new anchor.

b) Lock-off the anchors at no more than 50% of the accepted test load sustained during test or as determined by the Contract Administrator and install an additional anchor to compensate for the deficiency.

c) Post grout the anchor at a grouting pressure not exceeding 3.6 MPa or as recommended by the Contract Administrator and then conduct a proof test and apply the acceptance criteria to the test results. The post grouting shall be terminated immediately if any distress on the ground surface is observed during grouting.

d) Readjust the transfer load to 1.10 DL for an anchor that does not meet the lift-off criteria and repeat the test after a minimum of 48 hours. If the anchor does not meet the lift-off test criteria after completing this procedure, it shall be considered unacceptable.

942.07.13 Quality Control

942.07.13.01 General

In addition to the quality control procedures initiated by the Contractor, the following work shall also be done.

942.07.13.02 Quality of Grout Mixture

942.07.13.02.01 General

The Contractor shall be responsible for testing of bleeding, preparation and initial storage of grout cubes for determination of compressive strength, and delivery of the grout cubes to a testing laboratory designated by the Owner.

The Contractor shall employ staff from a testing company certified according to CSA A283, Certification for Additional Tests 1B, by an organization accredited by the Standards Council of Canada to carry out testing for bleeding, making, and curing of grout cubes and early strength determination.

Grout cubes for compressive strength test and testing of bleeding shall be made on a level, vibration free surface.

942.07.13.02.02 Testing for Bleeding

The testing for bleeding of the grout shall be according to CSA A23.2-1B.

Prior to the grouting operation, in the presence of the Contract Administrator, a trial batch shall be mixed and the grout tested for bleeding to ensure that the grout meets the requirements of this specification. The trial batch of grout shall not be used in the actual grouting operation.

During the grouting operation, bleeding measurements shall be performed on the grout sampled at the mixer. The measurements shall be performed at least once a day and as requested by the Contract Administrator.

The bleeding test results shall be submitted to the Contract Administrator in writing. The test results that indicate the grout is not meeting the requirements of the Contract Documents shall be reported immediately to the Contract Administrator and the grouting operation halted until the cause of the problem is identified and corrected.

942.07.13.02.03 Making, Curing, and Transportation of Cubes for Compressive Strength Tests

Grout cubes shall be prepared as follows on site from the grout pumped into the anchor body:

a) One set of grout cubes, consisting of three cubes, shall be made each day the grouting operations are carried out.

b) The grout cubes shall be prepared according to CSA A23.2-1B and stored at a temperature between 15 and 25 °C and shall not be moved prior to demoulding.

c) The grout cubes shall be demoulded and transported to the laboratory designated by the Owner within 24 hours.

d) The grout cubes shall be transported in a sealed white opaque plastic bag containing at least 250 mL of water and maintained at a temperature between 15 and 25 °C.

942.07.13.02.04 Early Strength Determination

The Contractor shall prepare and test additional grout cubes to determine when the grout has attained a strength of 20 MPa.

The laboratory conducting the test shall be certified as specified in this specification.

942.07.13.03 Certificate of Conformance

A completed Certificate of Conformance shall be submitted to the Contract Administrator upon completion of the anchor installation and stressing operations. The Qualification Verification Engineer's seal and signature shall be affixed on the completed Certificate of Conformance confirming that the anchors have been supplied, installed, and stressed in general conformance with the Working Drawings. The Certificate of Conformance shall also certify that the interim milestone inspections have been completed as specified.

942.07.14 Management of Excess Materials

Management of excess material shall be as specified in the Contract Documents.

942.09 MEASUREMENT FOR PAYMENT

942.09.01 Actual Measurement

942.09.01.01 Pre-Production Test Anchors and Production Anchors

Measurement of pre-production test anchors and production anchors shall be by length in metres along the actual length of the anchor from the anchor plate to the tip.

942.09.01.02 Post-Grouting of Bond Length

Measurement of post-grouting of bond length shall be by mass in kilograms of mixed grout used.

942.10 BASIS OF PAYMENT

942.10.01 Pre-Production Test Anchors - Item
Production Anchor - Item
Post-Grouting of Bond Length - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Appendix 942-A, November 2019
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Anchor hole diameter, orientation, and length tolerances and inclination. (942.07.06.01)

- Grout strength. (942.07.08)

- Number of pre-production test anchors for Owner designed systems. (942.07.12.05.01)

- Grout testing laboratory. (942.07.13.02.01)

The designer should determine if the following are required and, if so, they should be specify in the Contract Documents:

- Waterproofing anchor holes. (942.07.06.02)

- Post-grouting of bond length of anchors. (942.07.09)

- Bond stress. (942.07.12.05.01)

OPSS 942 contains information written for provincial contracts. To ensure completeness of municipal Contract Documents, the designer should invoke Appendix 942-B. The appendix contains supplemental requirements that modify OPSS 942 so it can be used by a municipality in its contracts.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

Appendix 942-B, November 2019
FOR USE IN MUNICIPAL CONTRACTS, WHEN REFERENCED IN THE CONTRACT DOCUMENTS

Note: This is a non-mandatory Additional Information Appendix intended to provide supplementary requirements for the OPS specification in a municipal contract, when the appendix is invoked by the Owner. It is written in mandatory language to permit invoking it by reference in the Contract Documents. If the appendix has not been invoked by reference in the Contract Documents, it does not apply.

Supplemental Requirements for Using OPSS 942 in Municipal Contracts

OPSS 942, Prestressed Soil and Rock Anchors, is amended as follows:

942.03 Definitions

Section 942.03 is amended by the deletion of the definitions for Certificate of Conformance and for Quality Verification Engineer.

Section 942.03 is amended by the addition of the following:

Certificate of Installation means a document issued by the design Engineer or design-checking Engineer confirming that the specified components of the Work are in general conformance with the requirements of the Contract Documents.

942.04.02.01 Working Drawings

The first paragraph of clause 942.04.02.01 is deleted in its entirety and replaced by the following:

The Contractor shall submit 5 sets of Working Drawings to the Contract Administrator at least 3 weeks prior to commencement of the work for the prestressed soil and rock anchor installation. Prior to making a submission, the seals and signatures of a design Engineer and a design-checking Engineer shall be affixed on the Working Drawings verifying that the drawings are consistent with the Contract Documents.

Clause 942.04.02.01 is amended by the addition of the following:

942.04.02.01.01 Return of Submissions

Two copies of each submission shall be returned as one of the following:

a) Stamped with the wording that allows for permission to construct. In this case, work can commence on receipt of the drawings by the Contractor.

b) Stamped with the wording that allows for permission to construct as noted. In this case, work can start on receipt of the drawings by the Contractor. The drawings shall be updated as noted and shall be sealed and signed by the design Engineer and the design-checking Engineer stating the drawings have been revised according to the noted comments.

c) Showing only required changes. In this case, the drawings shall be updated as required and the submission process repeated.

The Contractor shall have a copy of the stamped updated or accepted drawings at the site prior to the commencement of the work of the prestressed soil and rock anchors.

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942.04.02.02 Slurry

The first sentence of clause 942.04.02.02 is deleted in its entirety and replaced by the following:

At least 14 Days prior to the commencement of the work, the following information for the slurry shall be submitted to the Contract Administrator.

942.04.02.05 Milestone Inspections

The first sentence of clause 942.04.02.05 is deleted in its entirety and replaced by the following:

The design Engineer or the design-checking Engineer shall witness interim inspections of the following work:

942.07.12.01 General

The last paragraph of clause 942.07.12.01 is deleted in its entirety and replaced by the following:

Anchor tests shall be conducted at a time mutually acceptable to the Contractor and Contract Administrator. The design Engineer or the design-checking Engineer shall witness the testing.

942.07.12.06.05 Lift-Off Tests

The first paragraph of clause 942.07.12.06.05 is deleted in its entirety and replaced by the following:

A minimum of three lift-off tests shall be conducted at each site. The location of the anchor to be tested and the time of test shall be as determined by the design Engineer or design-checking Engineer. The lift-off test shall not be performed until 48 hours has elapsed after transferring the lock-off load. The method of testing shall be as detailed on the Working Drawings.

942.07.13.03 Certificate of Conformance

Clause 942.07.13.03 is deleted in its entirety and replaced by the following:

942.07.13.03 Certificate of Installation

A completed certificate of installation shall be submitted to the Contract Administrator upon completion of the anchor installation and stressing operations. The design Engineer or design-checking Engineer's seal and signature shall be affixed on the completed certificate of installation confirming that the anchors have been supplied, installed, and stressed in general conformance with the Working Drawings. The certificate of installation shall also certify that the interim milestone inspections have been completed as specified.

942.07 Construction

Section 942.07 is amended by the addition of the following:

942.07.15 As Built Drawings

As built drawings shall be prepared by the Contractor for the soil and rock anchor installations as follows:

Appendix 942-B

a) For all work incorporated in the completed structure that required the submission of Working Drawings.

For all changes to the original Contract Document requirements.

The as built drawings shall be submitted to the Contract Administrator, prior to the final acceptance of the work, in a reproducible format specified by the Owner.

The submission of as built drawings shall be accompanied by a letter bearing the seal and signature of an Engineer stating the as built drawings contain all the changes to the work.

The as built drawings shall bear the seal and signature of an Engineer.

CONSTRUCTION SPECIFICATION FOR GLASS FIBRE REINFORCED POLYMER REINFORCING BAR

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950-A **Commentary**

950.01 SCOPE

This specification covers the requirements for the fabrication and placing of glass fibre reinforced polymer (GFRP) reinforcing bar as internal reinforcement of concrete components.

950.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

950.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

950.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 905	Steel Reinforcement for Concrete

Ontario Ministry of Transportation Publications

Structural Manual
Guidelines for Inspection and Acceptance of Glass Fibre Reinforced Polymer (GFRP) Reinforcing Bars

CSA Standards

S6-14	Canadian Highway Bridge Design Code
S806-12	Design and Construction of Building Components with Fibre-Reinforced Polymers
S807-10	Specification for Fibre Reinforced Polymers

ASTM International

D 570 – 1998 (R2010)	Standard Test Method for Water Absorption of Plastics
D 578 – 2005 (R2011)	Standard Specification for Glass Fibre Strands
D 2584 – 2011	Standard Test Method for Ignition Loss of Cured Reinforced Resins
D 2734 – 2009	Void Content of Reinforced Plastics
D 3171 – 2011	Standard Test Method for Constituent Content of Composite Materials
D 3418 – 2012	Test Method for Transition Temperatures of Polymers by Thermal Analysis (DTA or DSC).
D 5028 – 2009	Curing Properties of Pultrusion Resin by Thermal Analysis
D 5117 – 2009	Standard Test Method for Dye Penetration of Solid Fiberglass Reinforced Pultruded Stock

D 7205 – 2006 (R2011) Standard Test Method for Tensile Properties of Fiber Reinforced Polymer Matrix Composite Bars
D 7617 – 2011 Standard Test Method for Transverse Shear Strength of Fiber-reinforced Polymer Matrix Composite Bars
E 1131 – 2008 (R2014) Standard Test Method for Compositional Analysis by Thermogravimetry
E 1640 – 2013 Standard Test Method for Assignment of the Glass Transition Temperature by Dynamic Mechanical Analysis

American Concrete Institute Publications

ACI 440.3R-04 Guide Test Methods for Fiber-Reinforced Polymers (FRPs) for Reinforcing or Strengthening Concrete Structures

950.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Engineer means a professional engineer licensed by the Professional Engineers Ontario to practice in the Province of Ontario.

Glass Fibre Reinforced Polymer (GFRP) means a fibre-reinforced composite with a polymeric matrix and continuous fibre reinforcement of glass.

Glass Transition Temperature means the midpoint of the temperature range over which an amorphous material changes from a brittle and vitreous state to a plastic state, or vice versa.

Lot means glass fibre reinforced polymer reinforcing bars made from the same batch of resin from the resin supplier. In addition,

a) straight bars, bent bars, and anchor headed bars shall be divided into separate lots;

b) for straight bars, bent bars, and anchor headed bars, a lot shall consist of bars of the same grade and diameter;

c) for bent bars and anchor headed bars, a lot shall consist of no more than 2000 bars;

d) bent bars of congruent shape may be considered as the same lot for establishing the number of samples for QC and QA testing;

e) bars manufactured by different machines for multiple lines of production shall be considered as separate lots.

f) bars shall be considered as a separate lot if there is an interruption in production or change in batch of raw material; and a lot shall consist of no more than seven (7) days of continuous production.

Congruent shapes are shapes that are congruent in every way with the same number of bends and angles, except that the length of the straight portions could be different.

Structural Component means a major portion of a bridge structure such as bridge deck, barrier wall, pier cap, etc.

Wet Glass Transition Temperature means the glass transition temperature, determined when the sample is fully saturated.

950.04 DESIGN AND SUBMISSION REQUIREMENTS

950.04.01 Design Requirements

Design shall be according to CSA S6 and the Structural Manual.

950.04.02 Submission Requirements

950.04.02.01 GRFP Quality Control Report

Two copies of the GFRP Quality Control Report, signed and sealed by the suppliers' Engineer for all the materials delivered to the site shall be submitted to the Contract Administrator prior to the placement of the reinforcement. The report shall contain the following information:

a) Production information including:
   i. Supplier;
   ii. Lot number of bars;
   iii. Batch number of resin;
   iv. The start and end date of production for each production lot of material; and
   v. The total linear metres produced in each lot for straight bars or the total number of bars in each lot for bent bars and anchor headed bars.

b) Summary of all material test results listed in order as identified in Table 2 with the following information for each property:
   i. The actual number of samples tested for each lot;
   ii. The result of every test as specified in the Quality Control subsection of this specification;
   iii. The average and standard deviation of test results; and
   iv. The minimum result for tensile strength, tensile elongation, transverse shear strength, and bend strength obtained from testing of the required samples.

950.04.02.02 Working Drawings

One hard-copy set and one electronic PDF of GFRP Working Drawings, including supporting documentation, shall be submitted to the Contract Administrator for information purposes at least seven (7) Days prior to delivery of bars. An Engineer's seal and signature shall be affixed on the Working Drawings verifying that they are consistent with the Contract Documents.

The Working Drawings shall include the following information:

a) bar placing drawings that include quantity, bar size, location and spacing for all bars.

b) bar schedule that includes quantity, bar size, type, length and bending dimensions.

The supporting documentation shall include the following information:

a) Manufacturer's instructions on how to deliver, handle, store, and protect the bars.

b) Manufacturer's recommended materials and procedures for removal of unacceptable material present on the bars.

A sealed and signed copy of the Working Drawings shall be kept at the site before and during the placing of bars.

When the Contractor intends to substitute bars, a proposal shall be submitted for approval by the Owner. Submission of the proposal and the Working Drawings shall be at least 3 weeks before bar installation.

950.04.02.03 Protection Plan for Placed and Partially Embedded Bars

At least seven (7) Days prior to the commencement of installation of bars, a plan describing the methods to be used to protect bars shall be submitted to the Contract Administrator. The protection plan shall address the following hazards and situations:

a) Contamination of placed or partially embedded bars from concrete splatter from an adjacent concreting operation.

b) Movement of bars from concreting operations that will leave partially embedded bars out of tolerance for subsequent work.

950.05 MATERIALS

950.05.01 Bar Types

Bars shall be grade III.

All bars in the same structural component shall be supplied by the same manufacturer; there shall be no mixing of products from different manufacturers in a component unless permitted in the Contract Documents.

Where the Contract Documents specify a particular product, there shall be no substitution unless approved by the Owner. Companies and products that are conditionally prequalified might not have been in full production yet; it is the responsibility of the Contractor to ensure that the contractual requirements can be met, including all quality control testing and delivery schedule.

950.05.02 Material Requirements of Bars

Bars shall be according to the qualification requirements in CSA S807, and Tables 1 & 2 of this specification. In case of discrepancies between CSA S807 and Tables 1 & 2, the more stringent requirement shall apply. The physical and durability properties of bars shall meet or exceed the requirements for a durability classification of D1 as per CSA S807.

Binding material for bars shall be composed of thermoset vinyl ester resin that is homogeneous throughout the cross-section of the bar. Fibre reinforcement in the bars shall be continuous E-glass or E-CR glass fibres according to ASTM D 578.

950.05.03 Bar Identification

All bars to be used in the Work shall be legibly stamped by the manufacturer with the following information at no more than 2.0 m spacing for straight bars, and at least once per piece for bent bars and anchor headed bars:

a) Manufacturer’s name and symbol

b) Type of fibre

c) Designated bar diameter

d) Grade designation

e) Designated modulus of elasticity

f) Production lot or batch number

950.05.04 Associated Hardware

Fastening of bars shall be with coated tie wire, stainless steel wire or nylon ties.

Bar chairs for supporting bars shall be plastic.

950.05.05 GFRP Workmanship and Finish

The bars shall be uniform in diameter/size and free of defects that would be detrimental to the mechanical properties and durability. The surface finish shall be uniform, free of voids and air pockets, and similar to the product tested for qualification. Defects include, but are not limited to, exposed fibres, cracks, kinks, surface pitting, and discoloration.

Fabrication tolerances shall be according to OPSS 905.

950.07 CONSTRUCTION

950.07.01 Delivery, Handling, Storage, and Protection of Bars

Delivery, handling, storage, and protection of bars shall be according to the manufacturer's instructions and the following to prevent damage:

a) Bars shall be lifted, transported, and stored using multiple support points to prevent damage to the bars from sagging. Support points shall be no more than 4.0 m from one another. Bars shall be lifted using nylon slings or padded wire rope slings. Lifting of bundles of bars shall be with a strong back, spreader bar, multiple supports or a platform bridge. Bars shall be bundled and supported to prevent damage during transportation. Bars shall be stored clear of the ground on suitable protective cribbing. Stacks or bundles of bars shall have adequate blocking to prevent contact between the layers of bundles. Bars shall be stored separately from reinforcing steel bars with the bar tags maintained and clearly visible until ready for placing.

b) Bars shall not be dragged, dropped or impacted. Bars shall not be struck by hammers or any other equipment at any time. Bars that have been subjected to any of the previous unacceptable actions, or that show obvious signs of damage, shall be rejected, removed and replaced. Bars subject to removal shall be marked and removed in the presence of the Contract Administrator.

c) Bars shall be covered with opaque white polyethylene during storage. Bars installed in the structure or formwork, including those partially embedded in concrete, shall be protected from the elements by covering with opaque white polyethylene sheeting or equivalent protective material when the exposure time is expected to exceed or exceeds thirty (30) Days. The protection shall be adequately supported and secured in place. This protection shall be maintained until its removal is required for preparation for subsequent concrete placement.

d) Bars shall be protected from any abrasive blasting or pressure washing operation in their immediate vicinity by adequate covering or wrapping with protective material.

e) Bars, after placing, shall be protected from construction operations and traffic such that the bar and its finishing are not damaged. The surfaces shall be kept free of contamination and damage and the bars shall be protected from loading which may damage the bars.

950.07.02 Surface Condition of Bars

Bars shall be free of mud, oil, concrete or other contaminants, and surface finish defects that adversely affect bonding strength or other properties at the time the concrete is placed.

Bars shall be protected from contamination caused by concrete splatter during adjacent placements. Any concrete contamination shall be removed immediately while the concrete is still plastic without damaging the bars. Removal of other materials present on the bars shall be according to the materials and methods recommended by the bar manufacturer.

950.07.03 Placing

The bars shall be placed according to OPSS 905 with the following modifications unless otherwise specified in the Contract Documents:

Bars shall be accurately placed in the positions shown in the Contract Documents and held in the correct location during the operations of placing and consolidating concrete.

a) Bars shall be tied at least at every third intersection.

b) The maximum untied length of any bar shall be 900 mm.

c) Bar support chairs shall not exceed 900 mm average spacing in each direction.

d) Bars within the formwork shall be secured to prevent movement during concrete placement. The bars shall be supported or tied to resist settlement, floating upward, or movement in any direction during concrete placement. For overlays and other horizontal placement where there is no bottom mat of steel reinforcement to tie down the GFRP, the GFRP mat shall be anchored down directly to the concrete or formwork to prevent it from floating upward.

e) Field bending shall not be permitted.

f) Bent bars shall not be field cut. Field cutting of straight bars will be permitted only with the approval of the Contract Administrator. The field cutting shall be with a high speed cutter, fine blade saw, diamond blade, or masonry saw. The bars shall not be shear cut.

950.08 QUALITY ASSURANCE

950.08.01 General

The acceptance of bars shall be according to the requirements of this specification. Bars not meeting the requirements of the Contract Documents shall be rejected and shall not be included in the Work.

950.08.02 Sampling

Prior to placing the GFRP, the Contract Administrator shall randomly select 5 samples for quality assurance testing from each lot. The straight bar samples shall be cut to a length of 2.2 m by the Contractor. If a lot of straight bars does not contain any pieces that may be cut down to a length of 2.2 m, then the length requirement shall be waived and samples shall be taken from the available lengths as supplied. For bent bars and anchor headed bars, the Contract Administrator shall select 5 samples at random from each lot. Samples are not required for bent bars of a particular diameter and shape, or anchor headed bars, if the total number required in the Contract for each respective bar type is less than 50.

950.08.03 Testing

At the discretion of the Owner, quality assurance testing for any number of lots, and for any number of properties listed in Table 2 for each lot, shall be conducted by a laboratory designated by the Owner. The testing shall be performed according to the methods and requirements listed in Table 2, and shall be performed on the 5 quality assurance samples. The results will be provided to the Contractor when they are available.

950.08.04 Defects or Deficiencies

950.08.04.01 Test Results

A GFRP lot shall be rejected if any one of the tested quality assurance samples fails to meet the limits in Table 2 for the tested property.

950.08.04.02 Visual & Dimensional

GFRP that does not meet the specified finishing, surface conditions, or dimensional tolerances shall be rejected.

The MTO “Guidelines for Inspection and Acceptance of Glass Fibre Reinforced Polymer (GFRP) Reinforcing Bars” shall also be used as a basis for field inspection and rejection of bars.

950.08.05 Consequences of Rejection

All rejected GFRP lots or bars shall be replaced. The replacements shall be subjected to the requirements of this specification.

If any Work incorporates rejected GFRP lots or bars, then that Work shall be rejected.

950.10 BASIS OF PAYMENT

950.10.01 Glass Fibre Reinforced Polymer Reinforcing Bar - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment and Material to do the work.

Rejected GFRP lots or bars shall be replaced at no additional cost to the Owner.

Table 1
Tensile Strength and Modulus of Grade III Bars

Straight Bars			Bent Bars (Note 1)		
Designated Bar Diameters	**Minimum Specified Longitudinal Tensile Strength kN**	**Longitudinal Modulus of Elasticity Gpa (Min)**	**Designated Bar Diameters**	**Minimum Specified Longitudinal Tensile Strength kN**	**Longitudinal Modulus of Elasticity Gpa (Min)**
13	130	60	13	130	50
15	200		15	200	
20	280		20	252	
25	490		25	441	

Note 1: Tensile strength and modulus are given for the straight portion of the bent bar.

Table 2
Quality Control Test Requirements

Property	Standard for Test	Specified Limits
Cross-sectional area	CSA S806, Annex A, Determination of Cross-Sectional Area of FRP Reinforcement.	Minimum area not less than 95% of the nominal cross- sectional area. Maximum area not more than 120% of the nominal cross sectional area for bar diameter 13 mm to 20 mm; 115% for bar diameter greater than 20 mm; and 145% for bar diameter less than 13 mm. Nominal cross-sectional area shall be according to CSA-S807.
Longitudinal tensile strength for straight bars and straight portion of the bent bars	ASTM D 7205; or CSA S806, Annex C, Test Method for Tensile Properties of FRP Reinforcements.	Minimum values defined in Table 1
Longitudinal tensile modulus and ultimate elongation (for straight bars and straight portion of the bent bars)	ASTM D 7205; or CSA S806, Annex C, Test Method for Tensile Properties of FRP Reinforcements.	Minimum values of tensile modulus defined in Table 1; the ultimate elongation shall not be less than 1.2%.
Transverse shear strength	A ACI 440.3R-04, Test Method B.4, Test Method for Transverse Shear Strength of FRP Bars; or CSA S806, Annex L, Test Method for Shear Properties of FRP Rods; or, ASTM D 7617.	≥ 180 MPa for Grade III
Longitudinal tensile strength of FRP bent bars at bend locations	ACI 440.3R-04, Test Method B.5, Test Method for Strength of FRP Bent Bars and Stirrups at Bend Locations (Note 1) or ACI 440.3R-04, Test Method B.12, Test Method for Determining the Effect of Corner Radius on Tensile Strength of FRP Bars.	Minimum strength at the bend shall be at least 45% of the minimum strength of straight portion of bent bars. (Note 4)
Fibre content	The relevant of the following: ASTM D 3171 (Method I of Procedure G), ASTM E 1131, and ASTM D 2584.	Glass fibre content ≥ 70% by Weight.
Void content	ASTM D 2734 or ASTM D 5117	≤ 1% (ASTM D 2734); or if no voids or longitudinal cracks are observed after 15 min. of ASTM D 5117 test, this criterion shall be deemed to have been met.
Water absorption at 50 ºC for straight bars , straight portion and curved portion of bent bars and grids	ASTM D 570 Water Absorption of Plastics: Procedures 7.1 & 7.4, except that both tests shall be conducted at 50 ºC (Note 2)	< 0.25% for 24-hour immersion ≤ 0.45% after 1 week immersion (168 hours) for the long-term immersion test.
Cure ratio for straight bars, straight portion and curved portion of bent bars and grids	Test Method according to Appendix A of CSA S807; Calibration of DSC by Indium according to ASTM D 5028	≥ 95% of Cure Required for all straight bars and bent bars.
Wet glass transition temperature	ASTM D 3418 (Note 3) or ASTM E 1640	DSC ≥ 100 °C DMA ≥ 110 °C
Pullout Capacity of anchor headed bars	Embedded in concrete block (Note 1)	100 kN for 15 mm diameter bar with a maximum slip of 0.5 mm.

Note 1: Test may be conducted with high early strength concrete after the concrete reaches 30 MPa strength.
Note 2: Test is conducted at 50 ºC for both 24 hour immersion and long -term immersion, in order to shorten the time required for the test.
Note 3: Samples shall be saturated according to ASTM D 570, except that the temperature of 50 ºC shall be used for conditioning. A hermetically sealed pan shall be used to prevent volatilization.
Note 4: Minimum strength of straight portion according to Table 1.

Appendix 950-A, November 2017
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

- Specify location bars shall be placed. (950.07.03)

Related Ontario Provincial Standard Drawings

No information provided here.

Ontario Provincial Standards Unit
301 St. Paul St., 2nd Floor North
St. Catharines, ON L2R 7R4

REVISION INFORMATION SHEET

ONTARIO PROVINCIAL STANDARDS FOR ROADS AND PUBLIC WORKS

VOLUME 7
MUNICIPAL-ORIENTED
OPS GENERAL CONDITIONS OF CONTRACT
AND GENERAL AND CONSTRUCTION SPECIFICATIONS

MANUAL REVISION No. 23 **NOVMEBER 2022**

UPDATING ONTARIO PROVINCIAL STANDARDS FOR YOUR USE

Each roads and public works owner (Owner) is responsible for determining implementation dates and directions for use of Ontario Provincial Standards; therefore, manual holders are cautioned about immediately discarding superseded and cancelled standards.

ACCESSING AND OBTAINING ONTARIO PROVINCIAL STANDARDS

Individual OPS standards, revision packages, and complete manuals are available for download, free of charge, in PDF format, from the MTO Technical Publications website.

WAITING TO HEAR FROM YOU

Further news and information about the Ontario Provincial Standards organization can be obtained from the OPS website at www.ops.on.ca.

Questions should be directed by email to Ontario.Prov.Standards@ontario.ca

If you have a suggestion to revise a standard or you have a standard that works in your ministry, municipality, or area, send it to the OPS Administration, for review and possible inclusion into the Ontario Provincial Standards.

THIS MANUAL IS REVISED AS FOLLOWS:

Index Pages Volume 7

Remove the entire index and replace with the revised index.

Standard Specifications Volume 7

Superseded/Cancelled (Remove)		Revised/New (Insert)		Remarks
OPSS.MUNI	Dated	OPSS.MUNI	Dated	
202	Nov 2016	202	Nov 2022	**Construction Specification for Rock Removal, By Manual Scaling, Machine Scaling, or Trim Blasting** • See Summary of Revisions.
615	Nov 2017	615	Nov 2022	**Construction Specification for Installation of Poles** • See Summary of Revisions.
		773	Nov 2022	**Construction Specification for Wildlife Fence** • New specification.
811	Apr 2017	811	Nov 2022	**Construction Specification for Large Woody Debris** • See Summary of Revisions.
812	Apr 2017	812	Nov 2022	**Construction Specification for LUNKERS** • See Summary of Revisions.
908	Nov 2014	908	Nov 2022	**Construction Specification for Metal Railings for Structures** • See Summary of Revisions.
911	Nov 2014	911	Nov 2022	**Construction Specification for Coating Structural Steel Systems** • See Summary of Revisions.

SUMMARY OF REVISIONS

OPSS.MUNI 202

Construction Specification for Rock Removal, By Manual Scaling, Machine Scaling, or Trim Blasting

- Title: amended to remove reference to control blasting.
- Section 202.01 Scope: amended to remove reference to controlled blasting. References to controlled blasting throughout the specification removed.
- Section 202.03 Definitions: amended.
- Subsection 202.04.02 Submission Requirements: amended to require the name of the person responsible for the manual scaling work. Proof of training certification for all staff required, as well as a safety plan that includes the requirement of site-specific work methods, procedures, and recovery plans. A copy of the safety plan is to be kept on site both prior to and during the manual scaling work.
- Subsection 202.06.03 Excavator: height requirement of excavator amended to a minimum height of 10 metres.
- Clause 202.07.02.02: parameters of manual scaling amended, including rock cut sounding, and grubbing as required.
- Clause 202.07.02.03: parameters of machine scaling amended, including rock cut sounding, scaling, and grubbing as required.
- Clause 202.07.03.02: amended to reflect preferred OPS wording. Amended to specify vertical or battered holes shall have a maximum spacing of 750 mm or as approved by a Contract Administrator.
- Subsection 202.07.04 Management of Excess Material: amended to include that excess rock material shall be managed within the right-of-way by slope flattening at locations approved by the CA.
- Clause 202.09.01.01: measurement for rock excavation by machine scaling amended to be measured by the cumulative sum of the time in hours that the scaling crew actively and necessarily engaged on the work, reflecting wording in OPSS.MUNI 100.
- Clause 202.09.01.02: measurement for rock excavation by machine scaling amended to be measured by the cumulative sum of the time in hours that each individual scaling unit is actively and necessarily engaged on the work, reflecting wording in OPSS.MUNI 100.
- Clause 202.09.01.03: measurement of rock excavation by trim blasting amended to be measured by either length in metres or volume in cubic metres, as specified in the Contract Documents.
- Subsection 202.10.02 Disposal, Earth and Rock: added.
- Note to Designer added stating if rock excavation is required for reasons other than manual scaling, machine scaling, or trim blasting, to add a separate item under OPSS.MUNI 206.

OPSS.MUNI 615

Construction Specification for Installation of Poles

- Section 615.02 References: OPSS 1010 added, and CSA C83 and CSA G12 updated.
- New subsection 615.05.02 Granular Material added, and other subsections renumbered.
- Clause 615.07.03.01: new last paragraph added.

OPSS.MUNI 811

Construction Specification for Large Woody Debris

- Title amended to remove ‘for Waterbody Banks’ to reflect updates to OPSS.PROV 811.
- Subsection 811.01.01 Specification Significance and Use: amended to reflect preferred OPS wording.
- Section 811.02 References: OPSS 517 reference added and Ontario Water Resources Act reference removed.
- Section 811.03 Definitions: OPSS 182 reference added. References included in OPSS 182 removed

to avoid redundancy.

- Subsection 811.05.02 Backfill Stone: measurement requirement of backfill stone removed, replaced with 'as specified in the Contract Documents'. Wording amended to clarify that previously excavated waterbody bank material may be used in conjunction with backfill stone.
- Subsection 811.07.02 Installation: wording amended to clarify that excavated material may be reused or mixed with backfill stone for the final layer when backfilling. Requirement to create roughness on the waterbody bank removed.
- Subsection 811.07.04 Dewatering and Temporary Flow Control: title amended to include dewatering. Requirements for dewatering and/or temporary flow control requirements amended to OPSS 517.
- Subsection 811.09.02 Plan Quality Measurement: entire subsection added.
- Appendix 811-A Commentary Appendix: Designer actions amended to reflect requirements from specification and associated OPSD.

OPSS.MUNI 812

Construction Specification for LUNKERS

- Section 812.01 Scope: amended to remove the full term for LUNKERS, which is in the Definitions section. Amended to focus on the stability of waterbody banks and fish habitat enhancement.
- Section 812.02 References: OPSS 517, OPSS 1005 added. Fisheries Act and Water Resources Act removed.
- Section 812.03 Definitions: amended to apply definitions in OPSS 182 to the specification. Base stabilizing Stone, Deleterious Substance, High Water Level, Large Backfill Stone, Low Water Level, Streambed, Waterbody, Waterbody Bank, Watercourse definitions removed. LUNKERS, Spacer Stone definitions amended.
- Subsection 812.05.03 Waterbody Aggregates: previously titled Base Stabilizing Stone. Amended to change title of subsection and to note that waterbody aggregates shall be according to OPSS 1005 as well as the Contract Documents.
- Subsection 812.05.04 Large Backfill Stone: removed.
- Clause 812.07.02.01: amended to remove requirement that excavated bank materials shall be reused when backfilling. Streambed replaced with waterbody bed. Backfill stone replaced with waterbody aggregates. Mended to require excavated bank material to be installed as specified in the Contract Documents.
- Clause 812.07.02.02: amended to remove requirement for stone LUNKERS to be installed in the dry. Base stabilizing stone replaced with waterbody aggregates. Amended to require waterbody aggregates to be installed as specified in the Contract Documents.
- Subsection 812.07.04 Dewatering and Temporary Flow Control: title amended to include dewatering. Amended to require dewatering and/or temporary flow control to be according to OPSS 517.
- Subsection 812.09.02 Plan Quality Measurement: added.
- Appendix 812-A: amended to include all designer considerations.

OPSS.MUNI 908

Construction Specification for Metal Railings for Structures

- Title amended to remove metal traffic barriers.
- Section 908.01 Scope: amended to remove traffic barriers and metal railings, add inspector guard.
- Section 908.02 References: OPSS 911 and DSM added. External references updated.
- Section 908.03 Definitions: Anchorage Assembly, Combination Railing, Inspector Guard, Metal Raining, Notice to Proceed definitions added. Engineer and Quality Verification Engineer definitions removed. Barrier Wall Railing, Bicycle Railing, Manufacturer's Certificate of Conformance, Parapet Wall Railing, Pedestrian Railing definitions amended.
- Wording throughout specification amended to reflect preferred OPS wording.

- Clause 908.04.01.02: title amended. Subsection amended to require a Manufacturer's Certificate of conformance, Request to Proceed, and Notice to Proceed.
- Clause 908.04.01.03: added.
- Clause 908.04.01.04: added.
- Subsection 908.05.02 Barrier Wall Railing, Parapet Wall Railing, Pedestrian Railing, and Bicycle Railing: removed.
- Clause 908.05.01.01: amended to require studs to be according to ASTM A108, lock nuts to be according to ASTM A563, and washers to be according to ASTM F844. Requirement for plating to show no red rust after 1,000 hour exposure removed. Requirement for all steel surfaces to be protected according to CSA G164M removed.
- Clause 908.05.01.03: Amendment to be Type 304 or 316 stainless steel with matching nuts.
- Subsection 908.05.02 Inspector Guard: added.
- Subsection 908.05.05 Hot Dip Galvanizing: added.
- Subsection 908.05.07 Thermal Sprayed Metal Coatings: added.
- Subsection 908.05.08 Zinc-Tin-Copper Solder: added.
- Clause 908.07.01.02.02: added.
- Clause 908.07.01.02.03: added.
- Clause 908.07.01.02.04: added.
- Clause 908.07.01.02.05: added.
- Clause 908.07.01.02.06: Zinc-rich touch up paint section added. Reference to MTO's pre-qualified products list removed.
- Subsection 908.07.03 Installation of Metal Railings and Inspector Guard: added.
- Clause 908.07.04.01: added.
- Clause 908.07.04.02: added.
- Section 908.01 Quality Assurance: added.
- Section 908.09 Measurement for Payment: amended to remove metal traffic barrier, include combination railing and inspector guard.
- Section 908.10 Basis of Payment: amended to remove metal traffic barrier, include combination railing and inspector guard.
- OPSF 906-1 Manufacturer's Certificate of Conformance, OPSF 906-2 Request to Proceed, OPSF 906-3 Notice to Proceed: added.
- Appendix 908-A: amended to include Contract Document requirements due to changes in specification.

OPSS.MUNI 911

Construction Specification for Coating Structural Steel Systems

- Wording throughout specification amended to reflect preferred OPS wording.
- OPSS.MUNI 911 has been revised extensively. It is recommended that users read the entire specification, as there are major differences between this version of the specification and the previous version