

Ontario Provincial Standards for Roads and Public Works



- Volume 5 -

PROVINCIAL-ORIENTED

MTO GENERAL CONDITIONS OF CONTRACT AND
GENERAL & CONSTRUCTION SPECIFICATIONS



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Municipal
Engineers
Association

MANUAL REVISION RECORD

Provincial-Oriented

Volume 5 – MTO 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.

REVISION NUMBER	REVISION DATE	ENTERED BY	REVISION NUMBER	DATE	ENTERED BY
1	APRIL 2008	Included in new manuals	27		
2	NOV 2008	Included in new manuals	28		
3	APR 2010	Included in new manuals	29		
4	NOV 2010	Included in new manuals	30		
5	APR 2012	Included in new manuals	31		
6	NOV 2012	Included in new manuals	32		
7	NOV 2013	Included in new manuals	33		
8	NOV 2014	Included in new manuals	34		
9	APRIL 2015	Included in new manuals	35		
10	NOV 2015	Included in new manuals	36		
11	APRIL 2016	Included in new manuals	37		
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REVISION INFORMATION SHEET

ONTARIO PROVINCIAL STANDARDS FOR ROADS AND PUBLIC WORKS

VOLUME 5 PROVINCIAL-ORIENTED MTO GENERAL CONDITIONS OF CONTRACT AND GENERAL AND CONSTRUCTION SPECIFICATIONS

MANUAL REVISION #11

APRIL 2016

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for use of Ontario Provincial Standards; therefore, manual holders are cautioned about immediately discarding superseded and cancelled standards.

A NOTE TO DESIGNERS OF MUNICIPAL CONTRACTS REGARDING APPENDICES

There are a number of OPS specifications published with appendices containing supplemental requirements that modify the specification. These specifications contain information written for use in provincial contracts. The appendices contain supplemental requirements that modify the provincial requirements so the specifications can be used in municipal contracts. The specifications are easily identified, as the table of contents for each specification lists the appendix containing the supplemental requirements (e.g., Supplemental Requirements for Using OPSS XXX in Municipal Contracts).

Designers of municipal contracts should review each specification to determine if the supplemental requirements should be invoked in their contracts. To ensure completeness of municipal Contract Documents, designers should invoke the appendices by referencing them in the Contract Documents.

ACCESSING AND OBTAINING ONTARIO PROVINCIAL STANDARDS

The Ontario Provincial Standards for Roads and Public Works (OPS) manuals and the latest published updates for each of the eight OPS manuals are available as follows:

- Available electronically on the OPS/MTO website. Online access to the current, updated, and archived standards; indexes; OPS User Notes; and publication Revision Information Sheets are available free of charge at the site.
(<http://www.raqs.mto.gov.on.ca/techpubs/ops.nsf/OPSHomepage>)
- Hard-copy format available from Publications Ontario by telephone at 1-800-668-9938 or online. Updates and OPS manuals are available for a cost-recovery fee.
(www.publications.serviceontario.ca)

- The eight OPS manuals of standards are available on one CD in PDF format. The OPS drawings published in Volumes 3 and 4 are available in AutoCAD format on a separate CD. These CDs are available from Publications Ontario or by telephone at 1-800-668-9938 or online for a cost-recovery fee. The updates are not available on CDs as an update package.
(www.publications.serviceontario.ca)

At the Publications Ontario web page, you can type "Ontario Provincial Standards," "OPS," "OPSS," or "OPSD" in the search box, and all related products for the Ontario Provincial Standards will be listed, click on the item you wish to purchase, add the item to your cart, then follow the instructions to complete your order. If trying to order an OPS product online from Publications Ontario and it is shown as Out of Stock, you can backorder the product by telephone at 1-800-668-9938.

In order to receive the Municipal Engineers Association (MEA) purchase price, MEA members should visit the MEA website (www.municipalengineers.on.ca/) for the MEA Publications Ontario order form for hard-copy manuals and CDs.

MTO employees should contact Simon Leung, Account Representative at Publications Ontario, by email (simon.leung@ontario.ca) to set up an account in order to receive the MTO purchase price for technical publications, including the Ontario Provincial Standards.

Links to Publications Ontario and the Ontario Provincial Standards on the MTO Library website are available on the OPS website (www.ops.on.ca). Also on this site under News and Activities are notices for updates and changes in OPS.

Questions should be directed by email to Ontario.Prov.Standards@ontario.ca.

YOU SHOULD REGISTER YOUR OPS MANUALS AND CDs

Users of OPS do not receive notices of OPS updates as they had in the past. Methods of notification from Publications Ontario for the future are being investigated, and you will be informed of them as they become available. In the interim, an email will be sent to OPS users who have registered their OPS manuals and CDs with OPS.

Owners of OPS manuals, who have not yet done so, are requested to register their OPS hard-copy manuals and CDs with OPS by email at Ontario.Prov.Standards@ontario.ca. The registration form and submission instructions are available on the OPS website (www.ops.on.ca), Miscellaneous Info, OPS Forms.

WAITING TO HEAR FROM YOU

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 Head, OPS Administration, for review and possible inclusion into the Ontario Provincial Standards.

THIS MANUAL IS REVISED AS FOLLOWS:

Index Pages Volume 5

Remove the entire index and replace with the revised index.

Standard Specifications Volume 5

Superseded/Cancelled (Remove)		Revised/New (Insert)		Remarks
OPSS.PROV	Dated	OPSS.PROV	Dated	
320	November 2014	320	April 2016	“CONSTRUCTION SPECIFICATION FOR OPEN GRADE DRAINAGE LAYER” See Summary of Revisions.
732	November 2014	732	April 2016	“CONSTRUCTION SPECIFICATION FOR GUIDE RAIL END TREATMENT – STEEL BEAM ENERGY ATTENUATING TERMINAL SYSTEMS” See Summary of Revisions.
		903	April 2016	“CONSTRUCTION SPECIFICATION FOR DEEP FOUNDATIONS” See Summary of Revisions.

SUMMARY OF REVISIONS TO OPSS.PROV 320

CONSTRUCTION SPECIFICATION FOR OPEN GRADE DRAINAGE LAYER

- Section 320.02, References, OPSS 310, 1003, 1150, 1151, 1301, 1302; MTO Publication LS-604, LS-606, LS-608, LS-614, LS-618, LS-625, LS-630, LS-631 added.
- Section 320.03, Definitions, Duplicate Samples added.
- Section 320.04, Design and Submission Requirements, rewritten.
- Section 320.05, Materials, rewritten.
- Section 320.06, Equipment, rewritten.
- Section 320.07, Construction, rewritten.
- Section 320.08 Quality Assurance, rewritten.
- Section 320.10 Basis of Payment, rewritten.
- Table 1, Gradation Requirements (LS-602), revised.
- Table 2, Thickness Payment Factors revised and renumbered Table 3.
- Table 3, Porosity of OGD L Payment Factors revised and renumbered Table 4.
- New table, Table 2, Physical Property Requirements, added.

SUMMARY OF REVISIONS TO OPSS.PROV 732

CONSTRUCTION SPECIFICATION FOR GUIDE RAIL END TREATMENT – STEEL BEAM ENERGY ATTENUATING TERMINAL SYSTEMS

- Subsection 732.07.01, General; 2nd paragraph, new d) added; existing 3rd paragraph deleted. New Type M list added.
- Subsection 732.07.03, Steel Beam Guide Rail, 2nd paragraph, 2nd sentence; converted into Table 1 and new Table 2.
- Clause 732.09.01.01, Extruder Terminal System and Sequential Kinking Terminal System deleted.
- Subsection 732.10.01, Extruder Terminal System and Sequential Kinking Terminal System deleted.

SUMMARY OF REVISIONS TO OPSS.PROV 903

CONSTRUCTION SPECIFICATION FOR DEEP FOUNDATIONS

- This is a new PROV to replace OPSS 903 Nov 2009.
- Clause 903.07.02.02, Driving Shoes and Rock Points, has been rewritten
- Clause 903.07.02.07.01, General, first paragraph has been rewritten.
- Subsection 903.07.04, Displacement Caisson Piles, last sentence has been rewritten.
- Clause 903.07.08.03, Certificate of Conformance, has been rewritten.



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NOV 2015	182	Environmental Protection for Construction in and Around Waterbodies and on Waterbody Banks
NOV 2012	185	Temporary Flow Control for Construction in Waterbodies
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NOV 2014	203	Rock Stabilization
NOV 2014	206	Grading
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NOV 2013	212	Earth Borrow
NOV 2014	220	Wick Drain Installation
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APR 2012	308	Tack Coating and Joint Painting
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NOV 2015	314	Untreated Subbase, Base, Surface, Shoulder, Selected Subgrade, and Stockpiling
APR 2016	320	Open Graded Drainage Layer
NOV 2014	330	In-Place Full Depth Reclamation of Bituminous Pavement and Underlying Granular
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NOV 2015	335	Cold In-Place Recycling with Expanded Asphalt



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NOV 2014	363	Repairing Rigid Pavement with Precast Concrete Slabs
NOV 2014	365	Cross-Stitching Longitudinal Cracks in Concrete Pavement and Concrete Base
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NOV 2014	539	Temporary Protection Systems
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CURRENTLY NO SPECIFICATIONS		
DIVISION 7 - TRAFFIC SAFETY		
NOV 2015	721	Steel Beam Guide Rail and Cable Guide Rail
NOV 2015	723	Energy Attenuators
APR 2016	732	Guide Rail End Treatment - Steel Beam Energy Attenuating Terminal Systems
NOV 2014	771	Standard Highway Fence
DIVISION 8 - ENVIRONMENTAL AND LANDSCAPE		
NOV 2014	804	Seed and Cover
DIVISION 9 - STRUCTURAL		
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NOV 2014	908	Metal Traffic Barriers and Metal Railings for Structures
APR 2008	910	Stressing Systems for Post-Tensioning
NOV 2014	911	Coating Structural Steel Systems
NOV 2014	914	Waterproofing Bridge Decks with Applied Asphalt Membrane
NOV 2014	915	Sign Support Structures
NOV 2008	920	Deck Joint Assemblies, Preformed Seals, Joint Fillers, Joint Seals, Joint Sealing Compounds, and Waterstops - Structures
APR 2012	928	Structure Rehabilitation - Concrete Removal
NOV 2014	930	Structure Rehabilitation - Concrete Patches, Refacing, and Overlays
NOV 2014	935	Impressed Current Cathodic Protection System for Bridge Structures



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SECTION GC 1.0 - INTERPRETATION

GC 1.01 Captions

- .01 The captions appearing in these MTO General Conditions of Contract 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 these General Conditions of Contract or any provision hereof.
- .02 In the event of a conflict of a reference to the number and caption of a subsection, subsection, clause, or paragraph, reference shall be made to the caption.

GC 1.02 Abbreviations

- .01 The abbreviations listed 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
ANSI	-	American National Standards Institute
ASTM	-	ASTM International - formerly American Society for Testing and Materials
AWG	-	American Wire Gauge
AWWA	-	American Water Works Association
CESA	-	Canadian Engineering Standards Association
CGSB	-	Canadian General Standards Board
CSA	-	CSA Standards - formerly Canadian Standards Association
CWB	-	Canadian Welding Bureau
CVOR	-	Commercial Vehicle Operator's Registration
DSM	-	Designated Sources for Materials
GC	-	MTO General Conditions of Contract
MOE	-	Ministry of the Environment (Ontario)
MTO	-	Ontario Ministry of Transportation
MTC	-	Ministry of Transportation and Communications, now MTO
MUTCD	-	Manual of Uniform Traffic Control Devices, published by MTO
OPS	-	Ontario Provincial Standards
OPSS	-	Ontario Provincial Standard Specification
OPSD	-	Ontario Provincial Standard Drawing
OTM	-	Ontario Traffic Manual
PEO	-	Professional Engineers Ontario
SAE	-	Society of Automotive Engineers
SSPC	-	Structural Steel Painting Council
TRA	-	The Road Authority
UL	-	Underwriters Laboratories
ULC	-	Underwriters Laboratories Canada

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 Ontario Provincial Standards

- .01 Regardless of the publishing date on OPSSs and OPSDs contained in the OPS manuals and on a MTO website, the Standards applicable to this Contract are listed in the schedule of Provisions, Plans, Standard Drawings, Specifications, and MTO General Conditions of Contract.

- .02 When an OPSS contains an appendix, the appendix is deleted in its entirety and is not invoked unless specified elsewhere in the Contract Documents. When an appendix is invoked, the information contained in the appendix shall form part of the specification.

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 the following books of the Ontario Traffic Manual:

Book 1	-	Introduction to the Ontario Traffic Manual;
Book 1A	-	Illustrated Sign and Signal Display Index;
Book 1B	-	Sign Design Principles;
Book 1C	-	Positive Guidance Toolkit;
Book 5	-	Regulatory Signs;
Book 6	-	Warning Signs;
Book 7	-	Temporary Conditions (and Temporary Conditions Field Edition);
Book 11	-	Pavement, Hazard and Delineation Markings;
Book 12	-	Traffic Signals.

- .02 Any reference in the Contract Documents to OTM shall be deemed to be the Ontario Traffic Manual Books 1, 1A, 1B, 1C, 5, 6, 7, 11, and 12.
- .03 The Contractor shall comply with the applicable requirements of the above OTM books.

GC 1.06 Conflict of Interest

- .01 The Contractor, any of the Subcontractors and any of their respective advisors, partners, directors, officers, employees, agents, and volunteers shall not engage in any activity or provide any services to the Minister where such activity or the provision of such services, creates a conflict of interest (actually or potentially in the sole opinion of the Minister) with the provision of services pursuant to this Contract. The Contractor acknowledges and agrees that it shall be a conflict of interest for it to use confidential information of the Crown relevant to the services where the Minister has not specifically authorized such use.
- .02 The Contractor shall disclose to the Minister, without delay, any actual or potential situation that may be reasonably interpreted as either a conflict of interest or a potential conflict of interest.
- .03 A breach of this section by the Contractor shall entitle the Minister to terminate the Contract, in addition to any other remedies that the Minister has in this Contract, in law or in equity.

GC 1.07 Definitions

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

Abnormal Weather means an extreme climatic condition characterized by wind speed, air temperature, precipitation, or snowfall depth, that is less than or greater than 1½ standard deviations from the mean determined from the weather records of the 25 years immediately preceding the tender opening date.

Access Road means a private road built or existing road used by the Contractor to gain access to the Work or to a source of material.

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

Addendum means an addition to or a change in the Contract Documents issued prior to tender closing.

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

Aggregate means gravel, sand, clay, earth, shale, stone, limestone, dolostone, sandstone, marble, granite, or rock other than metallic ores, slag, and clinkers.

Agreement means the signed document between the Minister or delegated representative and the Contractor for the performance of the Work 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 with gutter, or sidewalk.

Business Day means any Day which is not:

- a) A Saturday or a Sunday or
- b) A Day observed as a holiday under the laws of the Province of Ontario or the federal laws of Canada applicable to the Province of Ontario.

Change in the Work means the deletion, extension, increase, decrease, or alteration of lines, grades, dimensions, quantities, methods, drawings, 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 order to the Contractor covering contingencies, extra work, increase or decrease in Contract quantities, and additions or alterations to the plans or specifications, within the scope of the Contract and establishing the basis of payment. Also means, a written authorization covering Additional Work.

Change Proposal means a proposal by the Contractor for a modification to the Contract Documents that is expected to result in design improvement benefits or a reduction in costs or both, or Contract Time.

Claim means any request for a modification in payment from the original tender bid price submission.

Commercial Motor Vehicle means as defined under Section 16 of the *Highway Traffic Act*, R.S.O. 1990, c. H.8, as amended.

Commercial Source means a place where Aggregate or a product containing Aggregate is made available for sale.

Construction Signs means all traffic control devices and signs, including vehicles, trailers, and the like that are provided to support signs, and equipment to supply sign lighting, but excludes Contract identification signs and Highway number markers, all as may be described in the OTM.

Constructor means, for the purposes of, and within the meaning of the *Occupational Health and Safety Act*, R.S.O. 1980, c. O.1, as amended, the Contractor who executes this 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 Bulletin means a publication of MTO on the MTO's website www.raqs.mto.gov.on.ca.

Contract Completion means the Work has passed all inspection and testing requirements, the Contractor has rectified all deficient Work, and the Contractor has fulfilled all obligations under the Contract, except warranty obligations.

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

Contract Documents means the Agreement, Tender, MTO General Conditions of Contract, Standard Specifications and Drawings, Special Provisions, Contract Drawings, Addenda incorporated into any aforementioned document, documents referenced in the aforementioned documents, and subsequent amendments to any of these documents made pursuant to the provisions of the Agreement.

Contract Drawings or **Contract Plans** mean drawings or plans 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 lists, quantity sheets, cross-sections, and Standard Drawings.

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

Contractor's Intellectual Property means Intellectual Property owned by the Contractor prior to its performance under this Contract or created by the Contractor during this Contract independently of the performance of Contractor obligations under this Contract.

Contract Time means the time stipulated in the Contract Documents for completion of the Work, including any extension of Contract Time made pursuant to the Contract Documents.

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

Cut-off Date means the date up to which a progress payment shall be made for work performed.

CVOR Abstract means a level 1 Commercial Vehicle Operator's Registration (CVOR) abstract obtained from MTO.

CVOR Certificate means a Commercial Vehicle Operator's Registration certificate issued under the *Highway Traffic Act*, R.S.O. 1990, c. H.8, as amended.

CVOR Holder means a person or company to whom a CVOR Certificate was issued that has not been cancelled nor currently under suspension.

Daily Work Records means daily records for any part of the Work detailing the work in question, names, and categories of workers and hours worked or on standby; types and quantities of Equipment and number of hours in use and/or on standby; and description and quantities of Material used.

Day means a calendar day.

Earth Grade means the earth surface, whether in cut or fill, as prepared for the Base or Subbase.

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

Environmental Incident means an event such as a spill, discharge, emission, release, or escape of a material, pollutant, contaminant, deleterious substance, or dangerous good as defined in the legislation referenced in paragraph GC 7.13.02.01.

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.

Grade means the required elevation of work.

Grade Line means a reference line representing the Grade in profile or longitudinal section established for the control of work.

Hand Tools means tools that are commonly called tools or implements of the trade and include small power tools. Individually, a tool shall be considered as a Hand Tool where the maximum cost is \$400.

Haul Road means any public road excluding the road under Contract that forms part of a Material haul route.

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 that result immediately there from that prevents the Contractor from proceeding with the Controlling Operation.

Inspector means any person, partnership, or corporation appointed by the Contract Administrator to participate in the inspection of the Work and the Material to be used in the Work.

Intellectual Property means any intellectual, industrial, or other proprietary right of any type in any form protected under the laws of Canada, any foreign country, or any political subdivision of any country, including, without limitation, any intellectual, industrial, or proprietary rights protected by legislation, by common law, or at equity.

Labour and Material Payment Bond means the type of security furnished to the Owner to guarantee payment of prescribed debts of the Contractor covered by the bond.

Lump Sum Item means a tender item indicating a portion of the Work for which payment shall 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 on the basis of its actual or estimated tender quantity, whichever is the greater, multiplied by its tender unit price, which is equal to or greater than the lesser of:

- a) \$200,000, or
- b) 5% of the total tender value calculated on the basis of 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.

Newly Created Intellectual Property means any Intellectual Property created by the Contractor in the course of performance of the Contractor's obligations under this Contract.

Owner means the party to the Agreement 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, or other bituminous surfaces.

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

Person means an individual, corporation, partnership, joint venture, association, trust, pension fund, union, governmental agency, board, tribunal, ministry, commission, or department and the heirs, beneficiaries, executors, legal representatives, or administrators of a person to whom the context can apply according to law.

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

Profile Grade means the required elevation of the surface of the Base.

Quantity Sheet means a list of the locations, estimated design quantities, and other details of Work to be completed for tender items.

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

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 was integral with the parent mass prior to removal.

Rates of Interest means the interest rates determined by the Treasurer of Ontario and that are issued by and available from the Owner.

Record Drawings mean marked-up Contract Drawings prepared by the Contractor that show all differences, design changes, and deviations from the original Contract Drawings.

Records mean any books, payrolls, accounts, or other information that relate to the Work or any Change in the Work or Claims arising there from.

Regional Contracts Office means the Contracts Office in the MTO Region administering the Contract.

Release from Warranty Certificate means the certificate prepared by the Owner releasing the Contractor from all warranty obligations at the end of the last expiring warranty period.

Road Allowance means the lands acquired at any time for use as a Highway.

Roadbed means that part of the Work which is designed to support the Roadway.

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

Rock Grade means the rock surface, whether in cut or fill, that has been prepared for the Base or Subbase.

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

Special Provision means special direction within the Contract Documents containing requirements particular to the Work.

Standard means, when used alone, the generic term for Standard Specifications and Standard Drawings.

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

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

Subcontractor means a person, firm, or corporation undertaking the execution of a part of the Work by virtue of a contract with the Contractor.

Subgrade means the Earth Grade or Rock Grade.

Substructure means all of that part of a structure, including backwalls, wingwalls, and wing protection railings, below:

- a) The bearings of single and continuous span bridges.
- b) Skewbacks of arches and tops of footings of rigid frame bridges.

Superintendent means the Contractor's authorized representative in responsible charge of the Work.

Superstructure means all that part of a structure, excluding backwalls, wingwalls, and wing protection railings, above:

- a) The bearing seat of single and continuous span bridges.
- b) Skewbacks of arches and tops of footings of rigid frame bridges.

Surety means the person, partnership, or corporation, other than the Contractor, executing a bond provided by the Contractor.

Time and Material means costs calculated according to subsection GC 8.03, Payment on a Time and Material Basis.

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

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

Working Area means all the land and all the 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 on which the Contractor is prevented by weather or conditions resulting immediately thereafter, 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 the Controlling Operation by reason of:
 - i. Any breach of Contract or prevention by the Owner, by any other Contractor of the Owner, or by any employee of any one of them.

- ii. Non-delivery of Owner supplied materials.
- iii. Any cause beyond the reasonable control of the Contractor that can be substantiated by the Contractor.

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 falsework and formwork plans, roadway protection plans, shop drawings, shop plans, or erection diagrams.

GC 1.08 Substantial Performance

- .01 The Work is substantially performed:
 - a) When the Work or a substantial part thereof has passed inspection and testing and is ready for use or is being used for the intended purposes; and
 - b) When the Work to be performed under the Contract is capable of completion or, where there is a known defect, correction, at a cost of not more than:
 - i. 3% of the first \$500,000 of the Contract price,
 - ii. 2% of the next \$500,000 of the Contract price, and
 - iii. 1% of the balance of the Contract price
- .02 For the purpose of this Contract where the Work or a substantial part thereof is ready for use or is being used for the purposes intended and the remainder of the Work cannot be completed expeditiously for reasons beyond the control of the Contractor or, where the Owner and the Contractor agree not to complete the Work expeditiously, the price of the services or Materials remaining to be supplied and required to complete the Work shall be deducted from the Contract price in determining substantial performance.

GC 1.09 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.
- .02 The words "Ministry of Transportation," "ministry," and "Owner" and the abbreviations "MTO" and "MTC" shall mean the Ontario Ministry of Transportation.

GC 1.10 Liens

- .01 A lien is preserved when the claimant has given the Owner a copy of the claim for lien together with the affidavit of verification within the time frame detailed in Section 34 of the *Construction Lien Act*, R.S.O. 1990, c. C.30, as amended (*Construction Lien Act*).
- .02 A preserved lien is perfected when the claimant commences an action in the courts to enforce the lien prior to the end of the period specified in Section 36 of the *Construction Lien Act*.

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) The location of all mainline underground Utilities that affects the Work shall be shown to a tolerance of 1.0m horizontal and 0.3m vertical
- .02 The Owner does not warrant interpretations of data or opinions expressed in any subsurface report available for the perusal of the Contractor and excluded from the Contract Documents
- .03 The Owner does not warrant any 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 order:
 - a) Agreement
 - b) Addenda
 - c) Special Provisions
 - d) Contract Drawings
 - e) Standard Specifications
 - f) Standard Drawings
 - g) Tender
 - h) MTO General Conditions of Contract
 - i) 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 Contract 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.
 - d) Drawings of a later date shall govern over those of an earlier date in the same series.
- .03 In the event of any conflict in the contents of Standards the following order of precedence shall govern:

- a) Ontario Provincial Standard Specifications and Drawings
 - b) Other Standards referenced by 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 Release from Warranty Certificate. 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. The Contract Administrator shall give a decision in writing within a reasonable time.
- .03 The Contract Administrator may inspect the Work for its conformity with the Contract Drawings and Standard Specifications and all Drawings, and to record the necessary data to establish payment quantities under the schedule of tender quantities and unit prices or to make an assessment of the value of the work completed in the case of a lump sum price Contract.
- .04 The Contract Administrator shall approve the amounts owing to the Contractor under this Contract and shall issue certificates for payment in such amounts as provided for in section GC 8.0, Measurement and Payment.
- .05 The Contract Administrator shall, with reasonable promptness, review and take appropriate action upon the Contractor's submissions such as Working Drawings, product data, and samples according to the Contract Documents. Unless specified otherwise, the Contract Administrator shall respond to submissions requiring approval according to the Contract as soon as possible but not longer than 5 Business Days excluding any requests for extensions of Contract Time.
- .06 The Contract Administrator shall investigate all allegations of a change in the character of the Work made by the Contractor and issue appropriate instructions.
- .07 The Contract Administrator shall prepare and issue Change Orders.
- .08 The Contract Administrator shall be, in the first instance, the interpreter of the Contract Documents and the judge of the performance there under by both parties to the Contract. Interpretations and decisions of the Contract Administrator shall be consistent with the intent of the Contract Documents.
- .09 The Contract Administrator shall have the authority to reject work or Material which does not conform to the Contract Documents.
- .10 Defective work, whether the result of poor workmanship, use of defective Material, or damage through carelessness or other act or omission of the Contractor and whether incorporated in the Work or not, that has been rejected by the Contract Administrator as failing to conform to the Contract Documents shall be removed promptly from the Work by the Contractor and replaced or re-executed promptly according to the Contract Documents at no additional cost to the Owner.
- .11 Any part of the Work destroyed or damaged by such removals, replacements, or re-executions shall promptly be made good at no additional cost to the Owner.
- .12 If, in the opinion of the Contract Administrator, it is not expedient to correct defective work or work not performed according to 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 specified in

the Contract Documents, the amount of which shall be determined in the first instance by the Contract Administrator.

- .13 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.
- .14 The Contract Administrator shall have the authority to temporarily suspend the Work for such reasonable time as may be necessary to facilitate the checking of any portion of the Contractor's construction layout or the inspection of any portion of the Work. There shall not be any extra compensation for this suspension of work.

GC 3.02 Working Drawings

- .01 The Contractor shall arrange for the preparation of clearly identified and dated Working Drawings as specified in the Contract Documents.
- .02 The Contractor shall submit Working Drawings to the Contract Administrator with reasonable promptness and in orderly sequence so as to not cause delay in the Work. 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. At the time of submission, the Contractor shall notify the Contract Administrator in writing of any deviations from the Contract requirements that exist in the Working Drawings.
- .03 The Contractor shall make any changes in Working Drawings that the Contract Administrator may require 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.
- .04 The Contractor shall keep one set of the Working Drawings at the site at all times.

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

- .01 The Contractor shall, when instructed 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, at no additional cost to the Owner. The Contractor shall alter the sequence of operations on the Contract, when requested in writing, so as to avoid interference with other work.
- .02 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 completed at no additional cost to the Owner. If the emergency situation was not the fault of the Contractor, the Owner shall pay for the remedial work.

GC 3.05 Working Area

- .01 The Contractor's sheds, site offices, toilets, other temporary structures, and storage areas for Material and Equipment shall be grouped in a compact manner and maintained in a neat and orderly condition at all times.
- .02 The Contractor shall confine his construction operations to the Working Area so as not to interfere with public use. Should the Contractor require more space than that shown on the Contract Drawings, the Contractor shall obtain such space at no additional cost to the Owner.
- .03 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.

GC 3.06 Extension of Contract Time or Interim Completion Dates

- .01 An application for an extension of Contract Time or interim completion dates shall be made in writing by the Contractor on the Owner's Standard Form PH-CC-775, Extension of Time Request and Approval Form, to the Contract Administrator, as soon as the need for such extension becomes evident. The application for an extension of Contract Time shall enumerate the reasons and impact on the critical path schedule, and state the length of extension required.
- .02 Circumstances suitable for consideration include the following:
 - a) Delays: See subsection GC 3.07, Delays.
 - b) Changes in the Work: See clause GC 3.10.01, Changes in the Work.
 - c) Additional Work: See clause GC 3.10.02, Additional Work.
- .03 The Contract Time shall be extended for such additional time as approved by the Contract Administrator.
- .04 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, or civil commotions; or
 - b) Errors in the Contract Documents; or
 - c) An act or omission of the Owner, Contract Administrator, other contractors, or anyone employed or engaged by them directly or indirectly, contrary to the provisions of the Contract Documents; or
 - 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; or
 - e) The Contract Administrator giving notice under subsection GC 7.11, Suspension of Work; or

f) Abnormal Weather, provided that in the case of an application for an extension of Contract Time, due to the Abnormal Weather, the Contractor shall, with the Contractor's application, submit evidence from Environment Canada, together with detailed calculations in support of such application; or

g) Archaeological finds,

then the Contractor shall be granted an extension of Contract Time according to subsection GC 3.06, Extension of Contract Time or Interim Completion Dates, and shall be reimbursed by the Owner for reasonable costs incurred by the Contractor as the result of such delay.

.02 To determine if the weather encountered during the term of the Contract constitutes Abnormal Weather, the weather records used for the calculation of the 25-year mean and standard deviation shall be from the Environment Canada weather station nearest to the location of the Work. The weather conditions measured in time periods of 3 consecutive Days within a 30-Day period, a calendar month, or 3 consecutive calendar months shall be used to determine the values for the calculations. No other time periods shall be considered.

a) For precipitation and snowfall, the values for each year shall be the total amount over the time period.

b) For wind and temperature, the values for each year shall be either the highest or lowest value in the time period.

c) The same month or 3 month time period shall be used for each of the 25 years.

d) For a consecutive 3-Day period within a 30-Day period, the 30-Day period shall begin 15 Days prior to the start of the weather event that is suspected to be abnormal. Only the highest or lowest 3-Day value within the same 30-Day period shall be used for each of the preceding 25 years.

.03 If the Contractor is granted an extension of Contract Time, compensation for unabsorbed head office overhead shall be as follows:

$$\text{HOOH} = (\text{Te} (\text{OCv} \times 0.05) / \text{T}) - 0.05(\text{FCv} - \text{OCv})$$

Where:

HOOH: means head office overhead payment

Te: means approved extension of Contract Time in Days less the Days between December 1 and May 15 inclusive (for Working Day Contracts elapsed Days for approved Working Days)

OCv: means Original Contract tender value in dollars

T: means original Contract Time less the Days between December 1 and May 15 inclusive (Days for completion date contracts or elapsed Days for Working Day Contracts)

FCv: means final Contract value in dollars excluding: incentive/disincentive payments, material bonus/penalty payments, asphalt cement index payments and fuel price adjustments

The head office overhead payment shall not be negative.

For the purposes of establishing the start date to calculate Contract durations, the date shown on the Owners Standard Form PH-CC-700, Permission to Start Work, shall be considered as the start date. No other payment shall be made for Head Office overhead.

Payment for unabsorbed head office overhead shall be made after the Contract Completion Certificate has been issued.

- .04 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:
- a) Where an industry-wide strike delays the Work, the Contractor shall be granted an extension of Contract Time but not financial compensation (i.e., the strike is considered to be an excusable and non-compensable delay). The Contractor shall make application and shall document the extent to which Controlling Operations were delayed by the strike.
 - b) Bonuses and penalties shall apply to the revised interim and final completion dates.
- .05 If the Contractor's operations expose any items which may indicate an archaeological find, such as building remains, hardware, accumulations of bones, pottery, or arrowheads:
- a) The Contractor shall immediately notify the Contract Administrator and suspend operations within the area identified by the Contract Administrator.
 - b) Work shall remain suspended within that area until otherwise directed by the Contract Administrator in writing, according to subsection GC 7.11, Suspension of Work.
 - c) Any delay in the completion date of the Contract that is caused by such a cessation of construction operations shall be considered to be beyond the Contractor's control according to paragraph GC 3.07.01.
 - d) Any increases in the cost of the work to be done that are caused by such a cessation of construction operations shall be considered as a Change in the Work according to paragraph GC 3.10.01.01.
 - e) Any work directed or authorized in connection with an archaeological find shall be considered as Changes in the Work according to clause GC 3.10.01, Changes in the Work.

GC 3.08 Assignment of Contract

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

GC 3.09 Subcontracting by the Contractor

- .01 The Contractor may subcontract any portion of the Work, but the total of all sublets shall not exceed 60% of the total tender value without the written consent of the Contract Administrator, subject to these MTO General Conditions of Contract and any limitations established by the Owner.
- .02 The Contractor shall notify the Contract Administrator, in writing on the Owner's standard form PH-CC-742, Consent to Sublet, of the intention to subcontract where the subcontract comprises greater than 50% of the tender item value. Such notification shall identify the part of the Work, and the Subcontractor with whom it is intended.

- .03 The Contractor shall preserve and protect the rights of the parties under the Contract with respect to the work to be performed under subcontract and shall:
- a) Enter into agreements with the intended Subcontractors to require them to perform their work according to 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.
- .04 Subcontracting shall not be construed to relieve the Contractor from any obligation under the Contract or to impose any liability upon the Owner. Nothing contained in the Contract Documents shall create a contractual relationship between a Subcontractor and the Owner.
- .05 The Contractor shall not subcontract any part of the Work to a Subcontractor that has submitted the lowest tender for the Contract, and has subsequently failed to enter into a Contract with the Owner. The Owner shall not be responsible or liable for any costs or damages of the Contractor arising from the need of the Contractor to substitute a Subcontractor.

GC 3.10 Changes in the Work and Additional Work

GC 3.10.01 Changes in the Work

- .01 The Owner or the Contract Administrator, where so authorized, may, by order in writing, make Changes 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. Upon the receipt of such written order the Contractor shall proceed with the work and shall provide the Owner with a detailed cost estimate of the work described in the Change Order. The estimate shall identify the costs of salaries and wages, payroll burden, Equipment, Materials, and payments to Subcontractors. Alternatively, and with the agreement of the Contract Administrator, the Contractor may provide a cost estimate based on actual or revised Contract prices. The Contractor shall also estimate the impact on any incentives or disincentives.
- .02 The Contractor may apply for an extension of Contract Time according to the terms of subsection GC 3.06, Extension of Contract Time or Interim Completion Dates.
- .03 If the Changes in the Work relate solely to quantities, payment for the work shall be made according to the conditions specified in clause GC 8.01.02, Variations in Tender Quantities. If the Changes in the Work do not solely relate to quantities, then either the Owner or the Contractor may negotiate upwards or downwards the adjustment of the Contract price in respect of the Changes in the Work according to subsection GC 3.14, Clarification and Claims, or payment may be made according to the conditions contained in subsection GC 8.03, Payment on a Time and Material Basis.
- .04 The undisputed value of work performed as a result of a Change Order is eligible to be included in the Progress Payment Certificate. The Owner shall compensate the Contractor for the direct costs of labour, Materials, Equipment, and subcontracts. The interim payment shall be based on a mutually agreed lump sum, pro-rated for the percentage of work completed. In the case of failure to reach agreement, the interim payment shall be calculated according to subsection GC 8.03, Payment on a Time and Material Basis.

GC 3.10.02 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 work upon receipt of a Change Order establishing the basis of payment, the price, and the adjustment of Contract Time.

GC 3.10.03 Price Agreement Form

- .01 If the Contractor and Contract Administrator agree on the basis of payment and price when appropriate, a price agreement on the Owner's Standard Form PH-CC-856, Price Agreement for Change in the Work, Extra Work or Additional Work, shall be signed by both parties.

GC 3.10.04 Work Directive

- .01 If there is a dispute between the Owner and the Contractor whether a Change Order is required, and the Contractor does not proceed with the Work, the Owner may issue an Owners Standard Form PH-CC-857, Work Directive. Upon receipt of a Work Directive the Contractor shall proceed with the Work. The Contractor may pursue resolution of the dispute according to subsection GC 3.14, Clarification and Claims.

GC 3.11 Change Proposals after Contract Award

GC 3.11.01 Definitions

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

Alternative Type of Material means a substitute for a specified type of Material to be incorporated into a product and would involve a change that does not adversely affect the performance of the product.

Design Change means an alteration to a specified physical feature of a product or to the construction staging requirements that does not adversely affect the performance of the facility, and may include the use of an Alternative Type of Material that changes the physical dimensions of a product.

Method Change means an alteration to the specified means or process used to produce a product.

GC 3.11.02 Sharing of Cost Savings

- .01 The Contractor may propose cost-reducing Change Proposals after Contract award and gain a financial reward by receiving 50% of the savings resulting from a Change Proposal. If a Change Proposal is acceptable to the Owner, as determined by an Owner Change Proposal review team, the Contractor shall:

- a) Be reimbursed 100% for the agreed upon design/redesign cost as agreed upon at acceptance by the Owner in principle of a Change Proposal, and
- b) Receive payment of 50% of the net construction cost savings, as detailed in clause GC 3.11.05, Accepted Change Proposal Payment, resulting after preliminary design development at the Contractor's cost.

Items a) and b) are in addition to payment for the tendered cost for construction of a Change Proposal.

- .02 Standard submission forms and guidelines for their completion are available from the Contract Administrator.

GC 3.11.03 Conditions of Change Proposals

GC 3.11.03.01 Processing, General

- .01 Change Proposals under this provision shall be considered after award and when all applicable conditions are met. Change Proposals need not necessarily be completely equivalent to or meet specified requirements, except as otherwise specified in subsection GC 3.11, Change Proposals after Contract Award. Change Proposals shall be submitted on the applicable Owner Standard Forms and shall duplicate all the original text provided in the original standard forms.
- .02 Acceptance or rejection of the Change Proposal shall be at the sole discretion of the Owner. The Owner shall advise the Contractor of the reasons for rejection of a Change Proposal according to clause GC 3.11.03.09, Time Periods for Review.
- .03 Each proposed Change that affects a different set of Contract items shall be documented as a separate Change Proposal.
- .04 Ongoing costs and future life costs shall be evaluated, as detailed and explained on the Owner Standard Forms, and shall be noted considering, as a minimum, a perpetual/infinite life cycle using present worth value analysis, using a constant dollars concept, and a discount rate of 6%.
- .05 Change Proposals that take advantage of any errors or omissions in the plans for the as-designed project, or discrepancies between the as-designed project and the Special Provisions covering alternate designs, shall not be accepted. In the event that any error, omission, or discrepancy is discovered, the Contractor shall immediately notify the Contract Administrator. Failure to notify the Owner shall constitute a waiver of all claims for misunderstandings, ambiguities, or other situations resulting from the error, omission, or discrepancy.
- .06 The Contractor shall be responsible for all costs arising in connection with errors in the quantities related to the Change Proposal.
- .07 The Owner shall not be liable to the Contractor for failure to accept or act upon any Change Proposal nor for any delays attributable to any such Change Proposal.
- .08 No extension of Contract Time shall be permitted unless detailed in a Change Proposal and accepted by the Owner.
- .09 The Contractor shall be responsible for obtaining all regulatory approvals resulting from any Change Proposal.
- .10 The Owner shall be the sole judge of whether any Change Proposal is consistent with owner design policies and basic design criteria for the project.
- .11 The Contractor shall have no Claim against the Owner for any costs or delays due to the Owner's review or rejection of a Change Proposal, including but not limited to review for approval of designs, development costs, anticipated profits, or increased material or labour costs resulting from delays in the review of such Change Proposals.
- .12 If a Change Proposal is acceptable to the Owner, the Contractor shall construct the Change Proposal, and shall do the construction for the price bid for the Change Proposal identified by MTO as acceptable.
- .13 If the Change Proposal is acceptable in whole or in part, such acceptance shall be clarified by the Owner by means of a Change Order that shall specifically state that it is executed pursuant to subsection GC 3.11, Change Proposals after Contract Award.

- .14 Subcontractors may not submit a Change Proposal, except through the Contractor.
- .15 If the Owner accepts a design change, the Owner shall not give permission to proceed with such a Change Proposal until an agreement has been reached on the estimated value of the cost savings and on the Change Proposal design or redesign costs, or until there is a written agreement on a dispute resolution procedure to resolve any disagreement over the values. If a Change Proposal is rejected, no compensation shall be made for any costs associated with the Change Proposal, other than those accepted as part of a Change Proposal and/or other costs found to be acceptable to the Owner.
- .16 If the Owner already has under consideration certain revisions to the Contract or has approved certain changes in Standard Specifications or Drawings for general use that are subsequently incorporated into a Change Proposal, the Owner shall reject the Change Proposal and shall proceed with such revisions, if the Owner so desires and without any obligation to the Contractor. At the Owner's discretion, such changes may be made under subsection GC 3.10, Changes in the Work and Additional Work.

GC 3.11.03.02 Incomplete Change Proposals

- .01 The Owner reserves the right to reject any Change Proposal if the Change Proposal does not contain all required information or is not presented clearly. Without prejudice to this right, the Owner may request clarification when the intent of a Change Proposal is unclear. If supporting data is insufficient or unclear, this shall also be grounds for rejection of a Change Proposal.

GC 3.11.03.03 Proposals for Design Changes

- .01 When the Contract Documents do not contain a provision for a design change for a tender item, the Contractor's bid for the tender item shall be based on the specified/tendered design exclusive of any Change Proposal. Alternative designs presented under this provision may be proposed only after award. The Owner shall review the design Change Proposal and if the Change Proposal is acceptable to the Owner, the Contractor shall be responsible for the cost of all impacts on other construction item costs that are not included in the Change Proposal and for the schedule resulting from the Change Proposal.

GC 3.11.03.04 Design Changes

- .01 The situations described below are covered in OPSSs, and shall be used by the Owner to determine how a Change Proposal shall be handled:
 - a) When the Contract contains provisions for acceptable alternative designs (e.g., pipe sewers, cast-in-place vs. precast manholes, and culverts), the Contractor may proceed with any one of them with no need to negotiate cost savings after award based on this provision.
 - b) When the Contractor is specifically permitted in the Contract to design an alternative to the design specified in the Contract (e.g., track protection, work sequence, or staging requirements), the Contractor shall perform the design, and the associated cost shall be deemed to be included in the related Contract prices. The design shall be subject to Owner review and, if the alternative design is not acceptable, it shall be changed to meet the Owner's requirements at no additional cost to the Owner or revert to the original design as directed by the Owner.

- c) When the Contractor is responsible for the design of temporary work and no design has been provided in the Contract, or the design provided by the Owner is not sufficiently detailed to permit construction (e.g., formwork and falsework, dewatering, trench shoring, and roadway protection), it shall be understood that the costs for such work were included in the Contractor's original tendered bid, and the Contractor shall assume all the risk associated with bidding and constructing the design.

GC 3.11.03.05 Proposals for Method Changes

- .01 When the Contract Documents do not contain a provision for a method change for the tender item, or when the Contractor proposes an alternative method to the specified method, the Owner shall, under this provision, receive, review, and accept or reject an alternate method only after award of the Contract. The Contractor shall assume all of the risk in bidding the tender item with an alternate method and in using the alternate method. If the alternative method is acceptable to the Owner, or is acceptable with modifications, the Contractor shall be paid according to the payment conditions of subsection GC 3.11, Change Proposals after Contract Award. If a Change Proposal is rejected, no additional compensation shall be made.
- .02 The Contractor shall not start work with a proposed method change until the Owner has given written permission.
- .03 When the Contractor proposes to change the construction staging scheme identified in the Contract Documents, and where these changes are deemed by the Contract Administrator to be a significant departure from the Contract Documents, the Contractor shall submit 4 copies of a traffic management plan that:
 - a) Includes, as appropriate, the following documents:
 - i. Plan, profile, and cross-section drawings indicating the proposed changes to the horizontal and vertical alignment and any changes to the drainage; electrical; environmental; Pavement; structural; over-winter; work zone safety; and public safety, including pedestrian access, schemes for all affected construction and traffic stages.
 - ii. Revised signing and Pavement marking schemes.
 - iii. Revised detour, lane, or ramp closure schemes.
 - iv. A revised critical path schedule for the duration of the project.
 - b) Maintains the minimum standards as used in the Contract Documents for:
 - i. Highway geometrics.
 - ii. Pavement structures (i.e., type, depth and granular depths).
 - iii. Illumination and traffic signals needs.
 - iv. Over-winter conditions.
 - v. Environmental Protection (i.e., design measures, construction constraints and requirements and commitments in environmental documentation which may not be referred to in the Contract Documents).
 - c) Clearly identifies geometric design criteria used for:
 - i. Design speed.
 - ii. Vertical grades.
 - iii. Stopping sight distance.
 - iv. Vertical curves.
 - v. Horizontal curves.
 - vi. Superelevation.
 - vii. Lane widths.
 - viii. Shoulder widths.

- ix. Grades for side slopes.
 - x. Hazard offsets.
 - xi. Barrier warrants.
 - xii. Pavement crossfalls.
 - xiii. Shoulder crossfalls.
- d) Identifies any changes to the construction staging or traffic operations affecting municipal roadways to the Contract Administrator who shall notify the affected municipality. A minimum of 10 Business Days shall be provided to the municipality for their response.
 - e) Complies with the pavement marking and signing standards of the OTMs.
 - f) Complies with permitted time periods for lane and ramp restrictions and closures as specified in the Contract Documents.
 - g) Complies with environmental constraints and requirements as specified in the Contract Documents.
 - h) Meets current MTO Standards.

GC 3.11.03.06 Proposals for Alternative Types of Materials or Material Sources

- .01 The Contractor's Change Proposal for alternative types of Materials or Material sources shall include evidence that the Material or Material source meets the Owner's requirements in place at the time the Change Proposal is submitted.

GC 3.11.03.07 Proposal for a Combination of Design, Method, and Material Changes

- .01 When the Contract Documents do not contain a provision for a design change for a tender item, other than that permitted by a Change Proposal, and the proposed design change requires a different method from that specified in the Contract, the Change Proposal including the proposed method shall be considered a design change, and all the requirements of clause GC 3.11.03.03, Proposals for Design Changes, shall apply.

GC 3.11.03.08 Ownership and Copyright

GC 3.11.03.08.01 Intellectual Property

GC 3.11.03.08.01.01 Ownership of Intellectual Property

- .01 The Owner shall be the sole proprietor of any Newly Created Intellectual Property. The Contractor irrevocably assigns to and in favour of the Owner, and the Owner accepts every right, title, and interest in and to all Newly Created Intellectual Property in the Change Proposal, immediately following the creation thereof, for all time and irrevocably waives in favour of the Owner all rights of integrity and other moral rights to all Newly Created Intellectual Property in the Change Proposal, immediately following the creation thereof, for all time. To the extent that the Change Proposal includes, in whole or in part, the Contractor's Intellectual Property, the Contractor grants to the Owner a licence to use that Contractor's Intellectual Property in the manner contemplated in clause GC 3.11.03.08.01, Intellectual Property, of these MTO General Conditions of Contract, the total consideration for which shall be a portion of the payment of the lump sum tender item price to the Contractor by the Owner.

GC 3.11.03.08.01.02 Presumption Governing Ownership

- .01 The presumption governing the Contract shall be that the Owner shall be the sole proprietor of any Intellectual Property in any form contained in the Change Proposal. If the Contractor's Intellectual Property forms any part of the Change Proposal, the Contractor shall notify the Owner in the Change Proposal. In the absence of any such notice, the presumption shall remain that the Owner is the sole proprietor of any Intellectual Property contained in the Change Proposal.

GC 3.11.03.08.01.03 Contractor's Grant of Licence

- .01 For those parts of the Change Proposal that are the Contractor's Intellectual Property, the Contractor grants to the Owner for the sole purposes of resolving or remedying any breach of the Contract Documents or this warranty by the Contractor or for the Owner to undertake maintenance, rehabilitation, reconstruction, or construction work, a perpetual, world-wide, non-exclusive, irrevocable, transferable, royalty-free, fully-paid-up right and licence to:
- a) Use, modify, reproduce, and distribute, in any form, the identified Intellectual Property; and
 - b) Authorize other Persons, including agents, contractors, or Subcontractors, to do any of the former on behalf of the Owner.
- .02 The Owner acknowledges and agrees that the Contractor's Intellectual Property is the property of the Contractor and is highly valuable, confidential, and material to the interests, business, and affairs of the Contractor and that disclosure thereof would be detrimental to the interests, business, and affairs of the Contractor. The Owner agrees to maintain the confidentiality of the Contractor's Intellectual Property and that, subject to a court order or except as specifically permitted by the terms of these provisions, the Owner shall not disclose the Contractor's Intellectual Property to any person for any reason whatsoever other than to those persons who actually need to have knowledge of the Contractor's Intellectual Property for the sole purposes of resolving or remedying any breach of the Contract Documents or this warranty or for the Owner to undertake maintenance, rehabilitation, reconstruction, or construction work. The confidentiality obligation of the Owner shall not apply to those elements of the Contractor's Intellectual Property that are currently or hereafter become generally available to the public, provided such public availability has not occurred as a result of the disclosure by the Owner in contravention of this provision.

GC 3.11.03.08.01.04 No Restrictive Materials in Change Proposal

- .01 The Contractor shall not incorporate into any Change Proposal anything that would restrict the right of the Owner to modify, further develop, or otherwise use the Change Proposal in any way that the Owner deems necessary, or that would prevent the Owner from entering into any contract with any contractor other than the Contractor for the modification, further development, or other use of the Change Proposal.

GC 3.11.03.08.01.05 Assurances Regarding Moral Rights

- .01 At the request of the Owner, at any time or from time to time, the Contractor shall execute and agree to cause its directors, officers, employees, agents, partners, affiliates, volunteers, or Subcontractors to execute an irrevocable written waiver of any moral rights or other rights of integrity in the applicable Change Proposal in favour of the Owner. Such waiver to be in the form provided by the Owner, and which waiver may be invoked without restriction by any person authorized by the Owner to use the Change Proposal.
- .02 The Contractor shall deliver such written waivers to the Owner within 10 Business Days of the receipt of the request from the Owner.

GC 3.11.03.08.01.06 Further Assurances Regarding Copyright

- .01 At the request of the Owner, at any time or from time to time, the Contractor shall execute and agree to cause its directors, officers, employees, agents, partners, affiliates, volunteers, or Subcontractors to execute a written assignment of copyright in the applicable Change Proposal to the Owner in the form provided by the Owner. The Contractor shall deliver such written assignments to the Owner within 10 Business Days of the receipt of the request from the Owner. The Contractor shall assist the Owner in preparing any Canadian copyright registration that the Owner considers appropriate. The Contractor shall obtain or execute any other document reasonably required by the Owner to protect the Intellectual Property of the Owner.

GC 3.11.03.08.01.07 Owner May Prescribe Further Compliance

- .01 The Owner reserves the right to prescribe the specific manner in which the Contractor shall perform its obligations relating to the Intellectual Property.

GC 3.11.03.08.01.08 Survival

- .01 The obligations contained in clause GC 3.11.03, Conditions of Change Proposals, shall survive the termination or expiry of the Contract.

GC 3.11.03.08.02 Owner Rights

- .01 In submitting a Change Proposal under this provision, the Contractor agrees to the following:

- a) All plans, drawings, design reports, procedures, and programs prepared, conceived of, or produced or caused to be prepared, conceived of, or produced and delivered by or on behalf of the Contractor as part of an acceptable Change Proposal (the "Proposal") shall be the sole property of the Owner, except as otherwise provided below. The Contractor covenants that the Owner shall be the sole owner of the Proposal, and that none of such Proposal shall infringe the copyright, patent, or other right of any other Person.

For the purposes of the Copyright Act (Canada), the Contractor acknowledges that all Proposal shall be deemed to have been prepared under the direction and control of the Owner, and the copyright, except as otherwise provided below, shall belong to the Owner. The Contractor waives any moral rights it may have under the Copyright Act (Canada), concerning the Proposal.

All patents, copyrights, and other industrial and Intellectual Property rights, including trade secrets, arising in relation to the Proposal, if any, are hereby assigned to the Owner for its use, excepting any third party proprietary products, any licensed procedures, and any products licensed to a third party. Change Proposals shall clearly identify any third party proprietary products and licensed products and procedures to be used as a part of a Change Proposal. The Contractor shall take all reasonable steps, including the steps the Contractor takes to protect information, data, or other tangible and intangible property the Contractor owns and regards as proprietary or confidential, to ensure that such proprietary rights of the Owner are not violated.

The Contractor shall obtain all required assignments and releases of interest, acknowledgments, or waivers that the Owner considers necessary or advisable to transfer title and publication rights in and to the Proposal to the Owner, unless accepted otherwise.

- b) The Owner hereby grants the Contractor a non-exclusive, royalty-free licence to use the Proposal for any and all purposes.

- c) Without limitation, the Owner acknowledges that the Contractor shall have the right to use for the Contractor's own purposes outside of this Contract, any novel ideas and concepts developed by the Contractor.
- d) The Contractor shall not be liable in any manner whatsoever for the claims arising as a result of the use by the Owner of the Proposal in connection with projects other than this Contract. Further, the Contractor cannot warrant the fitness of or be responsible or liable for any Proposal that are only partially completed due to early termination or suspension of this Contract by the Owner, or if same have been altered, revised, modified, or amended without the written consent and knowledge of the Contractor or if such Proposal have been provided to the Owner on computer devices with removable storage and used on improper or incompatible computer processing equipment.
- e) The rights and privileges of the Owner, and the licence in favour of the Contractor provided for in these MTO General Conditions of Contract shall survive and shall not merge on the termination or other expiry of this Contract.

GC 3.11.03.09 Time Periods for Review

- .01 Any Change Proposal shall include/document the anticipated change in the construction schedule and shall account for and clearly indicate the desired and reasonable time period for review of same by the Owner. When there is no time period specified with the Change Proposal for review of designs, methods, or Working Drawings in the Contract Documents that are applicable to the Change Proposal, the Owner shall, unless it accepts the times suggested in the Change Proposal, review the Change Proposal expeditiously. The actual duration shall depend on the complexity of the Change Proposal; however, within 5 Business Days of receipt of the Change Proposal, the Owner shall notify the Contractor in writing:
 - a) If the Change Proposal requires clarification or further supporting information, and
 - b) Of the expected time period for review.
- .02 The Contractor shall be notified in writing of the acceptance or rejection of the Change Proposal not more than 20 Business Days after a fully documented and supported Change Proposal is received. If the Change Proposal is rejected, the reasons for the rejection shall be stated.
- .03 If the Owner fails to respond to the Change Proposals within the desired review time suggested in the Change Proposal or within the time stated in the notification in paragraph GC 3.11.03.09.01, b), the Contractor shall consider the Change Proposal rejected, and shall have no claim against the Owner as a result thereof.

GC 3.11.03.10 Risk Sharing/Warranty

- .01 As part of a Change Proposal, the Contractor shall outline and thoroughly explain warranties and other measures offered to reduce the Owner's risks, thus encouraging adoption of a Change Proposal. Shared risks and all risks that the Contractor is not prepared to accept shall also be outlined.

GC 3.11.04 Submission of Change Proposals

- .01 The Contract Administrator shall be notified of the Contractor's intention to submit a Change Proposal at least 5 Business Days before a Change Proposal is submitted.
- .02 Change Proposals shall be identified as Change Proposals submitted under subsection GC 3.11, Change Proposals after Contract Award, and shall include a completed standard cover sheet, the Owners Standard Forms, and the following:

- a) A description of the proposed Change Proposal, and the related design or redesign costs;
 - b) A detailed list of the Contract requirements that change, if the Change Proposal is adopted;
 - c) The tender items affected by the proposed changes, including any quantity variation, and any new items, applicable Standards, Special Provisions, and quantities;
 - d) A detailed estimate of the Contractor's cost of performing the work under the existing Contract, and under the proposed Change Proposals;
 - e) A description of the comparative advantages and disadvantages of the Change Proposals;
 - f) A revised construction schedule and an application for extension of Contract Time, if applicable; and
 - g) Completed Owner's Standard Change Proposal Forms and procedures shall be used, and shall document and support, for acceptance/review purposes, any Change Proposals.
- .03 Any aspect of a Change Proposal that involves or may involve (e.g., preliminary Change Proposal designs prepared for approval in principle) doing work or an act that is within the practice of professional engineering shall be designed by an Engineer and shall bear the seal and signature of the Engineer. Whatever the Contract specifies regarding stamp occurrences for such design work, the same requirement shall apply to designs or redesigns for a Change Proposal.

GC 3.11.05 Accepted Change Proposal Payment

- .01 If a Change Proposal is acceptable to the Owner, the changes and payment related to the savings thereto shall be authorized by means of a Change Order to the Contract. Compensation to the Contractor shall be made as follows:
- a) The Contractor's costs for development work (i.e., any preliminary work up to Owner acceptance in principle of a Change Proposal related to the Change Proposals) shall not be eligible for reimbursement.
 - b) The items for a Change Proposal shall become guaranteed maximum price items. Change proposal savings sharing shall be calculated as outlined in paragraph GC 3.11.05.01, c), and be shared equally between the Contractor and Owner; the Change Proposal design or redesign cost as agreed with MTO as acceptance in principle of the Change Proposal shall be fully reimbursed to the Contractor.
 - c) Change Proposal net construction cost savings Change Sharing payment shall be based on the following: the original directly related tendered construction price minus the price proposed (bid) to construct the Change Proposal and minus the cost of the Change Proposal design or redesign accepted by the Owner as a Change Proposal approval in principle. In addition to the shared savings payment total and the tendered price payment for the construction of redesigned Change Proposal work, the Contractor shall be reimbursed 100% for the price of the new Change Proposal design or redesign as agreed upon as acceptance of a Change Proposal in principle.
 - d) Unless otherwise advised in writing by the Contractor and agreed upon with the Owner, the Contractor's share of the change sharing savings shall be paid according to the following schedule: 50% of the Contractor's share of the agreed change sharing savings shall be paid as a part of the Owners progress payment following the Owner's acceptance of a Change Proposal in principle; the remaining Change Proposal costs shall be paid according to the percentage of Change Proposal work completed over the duration of the work of the Change

Proposal. The Contractor shall indicate, as a part of the Change Proposal, what items shall be used for each Change Proposal, shall get agreement with the Owner regarding such items, and shall outline, in the Change Proposal, any payment schedule that differs from clause GC 3.11.05, Accepted Change Proposal Payment.

- e) The Contractor may submit any Change Proposals for an approved Subcontractor provided that reimbursement shall be made by the Owner to the Contractor; the terms of the pass through to the Subcontractor shall have been satisfactorily negotiated between the Contractor and the Subcontractor, and be accepted by both before the Change Proposal is submitted to the Owner.

GC 3.12 Notices

- .01 The Contractor and the Owner shall provide each other with the mailing addresses, telephone numbers, facsimile terminal numbers, and email addresses for the Contract Administrator and the Superintendent at the commencement of the Work.
- .02 Any notice permitted or required to be given to the Owner or the Contractor shall be given according to the notice provision of the Agreement.
- .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.
- .04 Any document permitted or required to be given to the Contract Administrator or the Contractor 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 or by electronic transmission, and on the third Business Day after the date of mailing, if sent by mail.

GC 3.13 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 according to 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 according to the terms of the Contract.

GC 3.14 Clarification and Claims

GC 3.14.01 Claim Resolution Approach

- .01 Any Claim shall be addressed using the claim review process set out in subsection GC 3.14, Clarifications and Claims. Each stage of the process shall be completed before the next stage or another form of resolution is initiated.
- .02 If the parties mutually agree before the expiry of any time for the Owner to give a written decision at either the site or regional Claim review levels, the parties may extend such time to make a decision by up to 15 Business Days.

- .03 Any offer of settlement becomes null and void when either party requests that the resolution process proceed to the next stage or seeks to take another form of dispute resolution.
- .04 The Contractor and the Owner shall conduct, without prejudice, negotiations as part of the Claim review, and they agree not to disclose in any subsequent legal proceeding, any statements made, and documents or information obtained during the course of the Claim review and at any level of the Claim review that is not otherwise required to be disclosed by law.
- .05 Notwithstanding that the Claim is not resolved, the Contractor shall proceed with the Work to completion with due diligence and in an expeditious manner and such action shall not prejudice the Contractor in respect of any Claim it may have. The Contractor is not relieved from complying with any direction, order, Change Order, or Work Directive that is the subject of the Claim.

GC 3.14.02 Request for Clarification

- .01 The Contractor shall immediately submit a request for clarification, in writing, on the Owner's Standard Form PH-CC-750, Request for Clarification, when the Contractor becomes aware of or ought to be aware of any of the following:
 - a) A situation that is different than represented in the Contract Documents.
 - b) A Change Order where the Contractor disagrees with the basis of payment.
 - c) A situation where the Contractor believes the Contract Documents to be ambiguous.
 - d) Disagreement with Owner audit results.
 - e) A disagreement with the response to an extension of Contract Time request.

The Request for Clarification shall include a clear description of the situation with specific references to the Contract Documents. Notwithstanding the Contractor's Request for Clarification, the Contractor shall proceed with the work as directed by the Contract Administrator.

- .02 The Contract Administrator and Contractor shall exchange information to try to resolve the situation as detailed in the Request for Clarification. In any event, prior to the expiry of 75 Days from the date of receipt of the Request for Clarification, the Contract Administrator shall provide a written response to the Request for Clarification, which shall be deemed to be the final site response.

GC 3.14.03 Change Order Price Negotiations

- .01 The Contractor and Contract Administrator shall exchange information and negotiate to try to resolve the price for a Change Order where the price is to be negotiated. In any event, prior to the expiry of 75 Days from the date of receipt of Change Order, the Contract Administrator shall provide a written response stating the Contract Administrator's final price for the Change Order, which shall be deemed to be the final site response.
- .02 Immediately after the Change Order has been provided to the Contractor, Daily Work Records shall be prepared by the Contractor.

GC 3.14.04 Notice of Claim

- .01 In the event the situation is not resolved at the site, the Contractor, within 90 Days of the date of the Request for Clarification or Change Order when the issue is price, shall deliver a detailed written notice of Claim to the Regional Manager of Contracts, with a copy to the Contract Administrator. At the sole discretion of the Contractor, the notice of Claim may be delivered earlier. The Notice of Claim document shall describe information under the following headings in detail:

- a) Contract number and Contract description.
 - b) Claim title.
 - c) Name of Contractor.
 - d) Request for Clarification date and notice of Claim date.
 - e) Date on which the circumstances arose that gave rise to the Claim.
 - f) Detailed description of the nature of the Claim with dates, location, Materials, and Equipment involved and any other items relevant to the Claim.
 - g) Relevant provisions of the Contract which support the Claim and the reasons these provisions are relevant.
 - h) Name of each official, representative, or employee of the Owner involved in or knowledgeable about the Claim.
 - i) Name of each official, representative, or employee of the Contractor or Subcontractor, supplier, or other persons involved in or knowledgeable about the Claim.
 - j) Work affected by the Claim.
 - k) Change from tendered Contract.
 - l) Areas of work incurring additional costs.
 - m) Schedule changes.
 - n) Summary of proven actual or estimated additional costs, including direct labour, Material, and Equipment costs and Subcontractor costs.
 - o) Summary of proven indirect costs or estimated indirect costs, including standby, overhead, and impact costs.
 - p) Copies of all supporting documentation and records of the Contractor.
 - q) Particulars of any oral communications that support the Claim.
 - r) If the Contractor sought an extension of the Contract Time, the Contractor shall provide the particulars of the extension and the reasons therefore.
 - s) Any other information deemed necessary or appropriate.
- .02 When the Contractor completes the Work associated with the Claim and the Claim remains unresolved, the Contractor shall provide details of the actual costing in writing to the Contract Administrator and also to the appropriate respective levels of claim review process within 90 Days after completion of the affected work.
- .03 The Contractor is solely responsible for ensuring that it has provided all the information required in the Request for Clarification, as set out in clause GC 3.14.02, Request for Clarification, and the notice of Claim, as set out in clause GC 3.14.04, Notice of Claim.

- .04 The Contractor's failure to provide the notice of Claim as required shall result in the waiver of any Claim and the loss of compensation to the Contractor in respect of such Claim. However, if the Contractor provides the Owner with an explanation for the delay in providing the notice of Claim, which the Owner, in its sole discretion, can accept or reject for any reason, then, if the explanation is accepted, the Owner shall review the Claim according to the procedures set out herein. This provision shall not be interpreted so as to compel the Owner to review every Claim of the Contractor or any other person that does not comply with the requirements of the Contract, but rather is intended to allow the Owner the ability to consider those Claims that have failed to comply with the procedures and where the Owner, at its sole discretion, desires to consider such a Claim.

GC 3.14.05 Daily Work Records

- .01 After the Request for Clarification is provided, the Contractor shall immediately:
- a) Begin to keep Daily Work Records relating to the Request for Clarification as the Work is performed, as set out in clause GC 8.03.02, Daily Work Records.
 - b) Limit such Daily Work Records to the work directly impacted by the Request for Clarification.
 - c) Keep separate Daily Work Records for each individual Request for Clarification.
- .02 The keeping of Daily Work Records by the Contractor and any process to review or comment on those records shall not be construed to be the Owner's acceptance of the Claim for additional payment to which the Daily Work Records relate.

GC 3.14.06 Claim Review Process

- .01 The Contractor and the Owner shall attempt to resolve the Claim as detailed in clause GC 3.14.02, Request for Clarification.
- .02 Unless the Claim is resolved at the site, the Claim review shall then proceed through two additional levels: firstly, the regional Claim review between the Contractor and the Regional Contracts Office staff and secondly, when unresolved, the Head Office claim review between the Contractor and the Owner's Head Office.
- .03 Where the Contractor wishes to pursue the Claim to the regional Claim review, upon receipt of the notice of Claim, the Contractor and the staff from the office of the Regional Manager of Contracts shall commence the regional Claim review as soon as possible. The Regional Manager of Contracts shall make best efforts to resolve the Claim at the earliest opportunity and shall give a written decision to the Contractor within 60 Days after receiving a complete notice of Claim.
- .04 Where the Contractor desires to pursue the Claim to the Head Office Claim review, within 30 Days after the decision on the regional Claim review, the Contractor shall provide written notification to the Assistant Deputy Minister, Provincial Highways Management, with copies to the Contract Administrator, Regional Manager of Contracts and Head, Contract Claims, Contract Management Office, requesting that the Head Office level of Claim review commence. With this written notification, the Contractor shall provide a copy of the notice of Claim and a copy of any additional information provided during the regional Claim review. The Contractor and the Head Office shall commence head office Claim review as soon as possible. The Head Office staff shall make best efforts to resolve the Claim at the earliest opportunity and shall give a written decision to the Contractor within 60 Days after receiving the request to elevate the Claim to the Head Office level of Claim review.

- .05 The Contractor's failure to provide the written notification for the next level of the claim review, as set out in clause GC 3.14.06, Claim Review Process, shall preclude the Contractor from later seeking such further level of claim review and shall constitute an abandonment of the Claim and the loss of any compensation to the Contractor not previously agreed upon by the Owner in respect of such Claim. However, if the Contractor provides the owner with an explanation for the failure to provide the written notification for the next level of claim review, which the owner, in its sole discretion, can accept or reject for any reason, then, if the explanation is accepted, the Owner shall review the Claim according to the procedures set out herein. This provision shall not be interpreted so as to compel the Owner to review every Claim of the Contractor or any other person that does not comply with the requirements of the Contract, but rather is intended to allow the Owner the ability to consider those Claims that have failed to comply with the procedures and where the Owner, at its sole discretion, desires to consider such a Claim.
- .06 If the Owner requests additional information from the Contractor to justify the Claim, then the calculation of time set out in clause GC 3.14.06, Claim Review Process, to render a decision shall cease from the date of the request, until the Contractor has provided the information or a statement that it does not intend to provide the information.
- .07 If the Owner fails to resolve or make a decision on the Claim within the times detailed within paragraphs GC 3.14.06.03 and GC 3.14.06.04, then the Contractor, if the Contractor so chooses, may elevate the Claim to the next level of review. In the case of the Owner's Head Office Claim review, the Contractor, if the Contractor so chooses, may initiate mediation or explore alternative dispute resolution mechanisms with the Owner according to clause GC 3.14.07, Further Avenues for Dispute Resolution. In all such situations, the Contractor shall provide the Request for Clarification, as set out in clause GC 3.14.02, Request for Clarification, and the notice of Claim, as set out in clause GC 3.14.04, Notice of Claim, or required notification of the desire to proceed to the next level or seek alternative dispute resolution as required by paragraph GC 3.14.06.04 or clause GC 3.14.07, Further Avenues for Dispute Resolution, depending on status of the claim review.
- .08 Justification of the Claim and completing the notice of Claim to the satisfaction of the Owner is the full responsibility of the Contractor, failing which, the Owner shall rely upon the information provided by the Contractor to review the Claim at the risk of the Owner making an adverse decision by reason of the lack of supporting information.

GC 3.14.07 Further Avenues for Dispute Resolution

- .01 If the parties fail in their efforts to resolve the Claim after following the Claim review process of clause GC 3.14.06, Claim Review Process, upon the submission of a request by the Contractor to the Assistant Deputy Minister, Provincial Highways Management, within 30 Days of the Head Office Claim review decision, the parties shall use formal non-binding mediation to attempt the parties to resolve the dispute.
- .02 Subject to the direction of the mediator, as set out in the mediator's agreement, the following minimal rules shall apply to the mediation session:
- a) At least 14 Days before the mediation session, the Contractor shall prepare a statement and provide a copy to every other party and to the mediator.
 - b) At least 7 Days before the mediation session, the Owner shall prepare a statement and provide a copy to every other party and to the mediator.
 - c) The statement shall identify the factual and legal issues in dispute and briefly set out the position and interests of the party making the statement.
 - d) The party making the statement shall attach to the statement any documents that the party considers of central importance in the dispute.

- e) All communications at the mediation session and the mediator's notes and records shall be deemed to be without prejudice settlement discussions.
 - f) Each party is required to pay their own costs of the mediation session and an equal share of the mediator's fees and expenses for the mediation session.
- .03 If the parties fail in their efforts to resolve the Claim, then the parties agree that prior to resorting to litigation they shall explore alternative dispute resolution methods that are acceptable to the Owner. The Contractor shall provide written notice to the Assistant Deputy Minister, Provincial Highways Management, of the Contractor's desire to explore alternative dispute resolution methods within 30 Days of the decision of the Owner's Head Office level of claim review or within 30 Days of the completion of mediation where used. Subject to the rights reserved by the Owner, the parties agree to explore all avenues of alternative dispute resolution and shall attempt to negotiate the method and the terms for the alternative dispute resolution in an effort to settle the Claim before resorting to litigation. If the parties are unable to agree upon an alternative dispute resolution method and its terms within 60 Days of the request to explore alternative dispute resolution, then either party may resort to litigation. An example of the alternative dispute resolution that may be considered includes arbitration. Notwithstanding the foregoing, the Owner reserves the final right to determine the alternative dispute resolution to be used and the terms by which the alternative dispute resolution is to be governed.

SECTION GC 4.0 - OWNER'S RIGHTS AND RESPONSIBILITIES

GC 4.01 Working Area

- .01 The Owner shall acquire all property rights which 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 Management of Excess 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 which shall necessitate special materials management and disposition.
- .02 The Owner shall be responsible for any additional costs of removal, management, and disposition 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.

GC 4.03 Construction Affecting Railway Property

- .01 When construction affects railway property, the Owner shall pay the costs of all flagging and other traffic control measures required and provided by the railway company within the Working Area.

GC 4.04 Default by the Contractor

- .01 The Contractor shall be in default of the Contract if:
 - a) The Contractor fails to commence the Work or execute the Work properly or otherwise fails to comply with the requirements of the Contract to a substantial degree; or
 - b) If the Contractor 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.

GC 4.05 Notification of Default

- .01 The Owner shall give written notice of a default to the Contractor as soon as the Owner becomes aware of the alleged default, but failure to give such notice in a timely way shall not constitute acceptance of the default. The notice shall include instructions to correct the default within 5 Business Days.

GC 4.06 Contractor's Right to Correct a Default

- .01 The Contractor shall have the right within the 5 full Business 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 correction of the default cannot be completed within the 5 full Business 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 full Business Days following receipt of the notice;
 - b) Provides the Owner with an acceptable schedule for the progress of such correction; and
 - c) Completes the correction according to 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) Use the Contractor's Material within the Working Area which is intended to be incorporated into the Work, the whole subject to the right of third parties;
 - c) 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 7.18, General Warranty; and
 - f) Charge the Contractor for any damages the Owner may have sustained as a result of the default.

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 may, 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 Rights and Responsibilities, shall be exercised according to the conditions of the Performance Bond.

GC 4.13 Owner Audit

- .01 The Owner may inspect, review, and audit all Records associated with the Contract, including the Contractor's Records relating to the Work and Changes in the Work and Claims, at any time up to 24 months after releasing payment of the final holdback.
- .02 The Contractor shall supply certified copies of any part of the Contractor's Records whenever requested by the Owner.
- .03 Where the inspection, review, and audit reveals discrepancies in payment, the Contractor shall be advised immediately. The Contractor shall have the opportunity to dispute these discrepancies by immediately submitting a Request for Clarification.
- .04 Upon agreement with the results, any monies payable to the Contractor shall be payable within 30 Days. Interest back to the time the amount became payable shall not be paid.
- .05 Upon agreement with the audit results, any monies due to the Owner shall be payable within 30 Days together with interest due from the time the amount was over paid. Where such amounts are not paid within 30 Days, the Owner shall setoff such monies owing the Contractor from other contracts.

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 prices 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 provided by the Contractor shall be new, unless otherwise specified in the Contract.
- .02 Material shall be supplied from sources identified in the MTO DSM available on TRA website <http://www.roadauthority.com> that is current at the time of supply of the product. If there are revisions to the DSM, these shall be posted on TRA website on the first Business Day of the months of February, April, June, August, October, and December. Material for which there is no category in the DSM shall be supplied according to the Contract Documents. Material which 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.

Sources in the DSM have demonstrated their ability to produce material according to specified material specifications. However, the MTO does not warrant that these sources shall produce acceptable or sufficient Material for any contract. The Contractor shall make such independent investigation and examination as the Contractor deems necessary, to satisfy the Contractor as to the quality and quantity of the Material available from these sources, and to ensure that all Material supplied by them satisfies the requirements of the Contract Documents.

- .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 provided by the Contractor.
- .04 The Contractor shall obtain for the Contract Administrator the right to enter upon 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 complete and submit, on Owners Standard Form PH-A-106, List of Materials from Designated Sources, to the Contract Administrator indicating where the Contractor intends to obtain the designated source materials for the Contract. The Contractor shall notify the Contract Administrator of the sources of supply of all Material 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 dates.
- .07 Where the Standards 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, which shall be regarded as the standard of quality required by the Standard.
- .08 Prior to the commencement of Work the Contractor shall provide to the Contract Administrator a list of those products controlled under the Workplace Hazardous Material Information System (WHMIS) that the Contractor expects to use on the Contract. Related Material 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 Contract Administrator of changes to the list in writing and provide relevant Material Safety Data Sheets.

- .09 When a Material or Material source is deleted from the DSM list of pre-qualified Materials or Material sources after the tender opening date, the Owner shall be responsible for the extra costs of Material supply only, unless the Material production or Material source is controlled by the Contractor or Subcontractor. If the type of Material or Material source is pre-qualified after the date of tender opening, permission to use the Materials or Material sources shall not be given until an agreement has been reached on the estimated value of the cost savings to the Owner.

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 site 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 Owner Supplied Material

GC 5.04.01 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 10% for administration.

GC 5.04.02 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, 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 which 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 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 be used by the Contractor for purposes other than the Work under the Contract.

- .05 Empty reels, crates, containers, and other types 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, unless otherwise specified in the Contract Documents.
- .06 The Contractor shall provide the Contract Administrator, immediately upon receipt of each shipment, 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 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, and shall be responsible for all losses and damage which 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 provisions 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 shall be administered according to these MTO General Conditions of Contract.
- .03 The Contractor shall immediately inform the Contract Administrator of all damage and injuries which occur during the term of the Contract.
- .04 The Contractor shall not be responsible for loss and damage that occurs as a result of:
 - a) War;
 - b) Blockades and civil commotion;
 - c) Errors in the Contract Documents;
 - d) Acts or omissions of the Owner, the Contract Administrator, the Owner's agents, officers, and employees, or others not under the control of the Contractor but are within the Working Area with the Owner's permission.
- .05 The Contractor and the Contractor's Surety or Sureties 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, the Owner's 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 Owners Standard Form PH-CC-799, Certificate of Substantial Performance, for the Work or, where so specified in the Contract from the date of the Contract Completion Certificate.
- .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 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 paragraphs GC 6.02.01 and GC 6.02.02.
- .04 The Owner shall indemnify and hold harmless the Contractor, his 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 paragraph GC 6.03.04.

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 listed in these MTO General Conditions of Contract and specifically described under clause GC 6.03.02, Commercial General Liability Insurance, and clause GC 6.03.03, Automobile Liability Insurance, and such other insurance as may be specified in the Contract Documents.

GC 6.03.02 Commercial General Liability Insurance

- .01 Commercial General Liability Insurance on an occurrence basis for third party bodily injury, personal injury, and property damage shall have an inclusive limit of not less than \$5,000,000 per occurrence with \$2,000,000 products and completed operations aggregate. The policy is to include the following:
 - a) The Owner and the Contract Administrator as additional insured's with respect to liability arising in the course of performance of the Contractor's obligations under or otherwise in connection with the Contract Documents.
 - b) Contractual liability coverage.
 - c) Cross-liability clause.
 - d) Employer's liability coverage.
 - e) 30 Day written notice of cancellation, termination, or material change.
 - f) Non-owned automobile coverage, including standard contractual liability endorsement, with blanket coverage for hired automobiles.
- .02 The Contractor shall provide the Owner with proof of insurance required by these MTO General Conditions of Contract in the form of valid certificates of insurance acceptable to the Owner that references the Contract and confirms the required coverage, on or before the commencement of this Contract, and any renewal replacements on or before the expiry of any such insurance.
- .03 The Contractor shall submit annually on the anniversary of the execution of the Agreement to the Owner the proof of the continuation of the insurance as described in these MTO General Conditions of Contract or elsewhere in the Contract Documents in the form of valid certificates of insurance acceptable to the Owner that references the Contract and confirms the required coverage.

- .04 If the Contractor decides not to employ Subcontractors for operations requiring the use of explosives for blasting, pile driving or caisson work, or removal or weakening of support of property building or land, the certificate of insurance shall include the appropriate endorsements.
- .05 "Claims Made" insurance policies shall not be permitted.

GC 6.03.03 Automobile Liability Insurance

- .01 Automobile insurance in respect of licensed vehicles as per statutory requirements in Ontario shall have limits of not less than \$5,000,000 inclusive per occurrence for bodily injury, death, and damage to property, including accident benefits in the standard owner's form automobile policy providing third party liability and accident benefits insurance and covering licensed vehicles owned or operated by the Contractor and endorsed to provide the Owner with not less than 30 Days written notice in advance of any cancellation, change, or amendment restricting coverage.

GC 6.03.04 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 according to 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 insurer 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 loss or damage to the Work arising from the action of others, the Owner shall pay the Contractor the cost of restoring the Work as the restoration of the Work proceeds and according to the requirements of section GC 8.0, Measurement and Payment.

GC 6.03.05 Insurance Requirements and Duration

- .01 Unless specified otherwise, the insurance shall be maintained continuously from the commencement of the Work until 10 Days following the date of Contract Completion Certificate, and with respect to completed operations coverage for a period of not less than 24 months from the date of Contract Completion Certificate, and thereafter to be maintained for a further period of 4 years.
- .02 The Contractor shall provide the Owner, on a form acceptable to the Owner, proof of insurance prior to commencement of the Work, signed by an officer of the Contractor and either the underwriter or the broker.
- .03 The Contractor shall, on request of the Owner, 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 a signature by an officer of the Contractor and in addition, a signature by an officer of the insurer or the underwriter or the broker.
- .04 Unless specified otherwise the Contractor shall be responsible for the payment of deductible amounts under the policies.
- .05 If the Contractor fails to provide or maintain insurance as required in these MTO General Conditions of Contract 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.

- .06 If the Contractor fails to pay the cost of the insurance placed by the Owner within 30 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 tender 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 maintained in good standing until the fulfilment of the Contract.

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 which 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 written permission, on Owners Standard Form PH-CC-700, Permission to Start Work, duly signed by the Contract Administrator.

GC 7.01.03 Control and Responsibility

- .01 The Contractor shall have complete control of the Work and shall effectively direct, supervise, and undertake quality control activities for 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 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.
- .03 Notwithstanding paragraph GC 7.01.03.02, 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.

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 (*the Act*) and Ontario Regulation 213/91 (*Construction Projects*) and any other regulations under *the Act (the Regulations)* which may affect the performance of the Work, as the Constructor or employer, as the case may be. The Contractor shall ensure that:
- a) Worker safety is given first priority in planning, pricing, and performing the Work;
 - b) The Contractor's officers and supervisory employees have a working knowledge of the duties of a Constructor and employer under *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 Superintendent 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) The Contractor's supervisory employees carry out their duties in a diligent and responsible manner with due consideration for the health and safety of the workers; and
 - f) All Subcontractors performing part of the Work and their employees are properly protected from injury while they are at the work place.
- .02 When requested, the Contractor 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 *the Regulations*. The Contractor shall cooperate with representatives of the Owner and Ministry of Labour 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 The Contractor shall immediately, upon receipt, provide the Owner a copy of all correspondence from the Ministry of Labour including but not limited to Project Forms, Stop Work Orders, or Certificates of Offence.
- .04 For work inside confined spaces, including box girder bridges, detailed written procedures addressing the confined space requirements of *the Act* and *Construction Projects*, shall be clearly posted at the project site and available to all personnel, including the Contractor's workers, the Contract Administrator, MTO personnel, and Ministry of Labour inspectors. The procedures shall include the rescue procedures to be followed during a rescue or evacuation of all personnel from an unsafe condition or in the event of personal injury. The Contractor shall have personnel trained in rescue procedures readily available on site.

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 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 telephone numbers of the Contractor's representatives who can be contacted at any time to deal with matters relating to the Contract.
- .02 The Contractor shall designate a person to be responsible for traffic control and highway work zone safety. The designated person shall be a competent worker who is qualified because of:
- a) Knowledge, training, and experience to perform the duties;
 - b) Is familiar with Book 7 of the OTM; and
 - c) 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, and telephone number of the designated person. The designated person may have other responsibilities, including other construction sites, and need not be present in the Working Area at all times.

- .03 The Contractor shall maintain a daily, hard bound diary of the signs in use for temporary and long term traffic control. The diary shall be submitted with the final payment documents. For the duration of the Contract and within 24 hours of a request by the Contract Administrator, the Contractor shall provide the Contract Administrator full access to the diary. The following information shall be included in the diary:

- a) A schematic of the location of each existing sign by station, offset, and height above pavement.
- b) A schematic of the placement and re-location of all construction signs by station, offset, and height above pavement.
- c) Traffic accidents, including time of inspection, location of incident, and photographs.
- d) Time and date of daily sign inspections.

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 Critical Path Schedule

- .01 Initial and updated critical path schedules shall be prepared and submitted as detailed below:
 - a) 2 paper copies and 1 electronic copy in the format of the scheduling software and readable by the scheduling software of the initial construction schedule shall be submitted to the Regional Contracts Office within 7 Business Days of receipt of the acceptance of the tender.
 - b) 1 hard copy of the initial construction schedule shall also be submitted to the Contract Management Office, St. Catharines, with the executed copies of the Contract.
 - c) Where the Contractor has revised the initial construction schedule prior to the first site meeting, the revised construction schedule shall be submitted to the Contract Administrator at least 3 Business Days prior to the meeting.
 - d) 2 paper copies and 1 electronic copy in the format of the scheduling software and readable by the scheduling software of an updated schedule shall be prepared and submitted to the Contract Administrator not less than 3 Business Days prior to all regularly scheduled site meetings. All revisions shall be highlighted on the updated schedule. Updated schedules submitted shall reflect actual progress of the Work and any additions, deletions, or revisions to the Work that have arisen since the previous update. At regularly scheduled site meetings, the Contractor shall explain the revisions and any increase or decrease in resources required to complete the Work on time. At the Contract Administrator's request, and at no additional cost to the Owner, the Contractor shall submit an updated schedule within 7 Business Days of any major increase or decrease in quantities, or major change in the staging or perceived change in character of the Work.
 - e) All copies shall be legible and shall show the date the schedule was prepared.
- .02 The requirements for the construction schedule are detailed below:
 - a) The critical path method shall be used to prepare and update the construction schedule. The initial and updated construction schedules shall consist of a time scaled network diagram with its related bar charts or a time scaled linear diagram.
 - b) 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.

- c) For Contracts which specify a Contract Completion date, the construction time shown on the initial construction schedule shall not extend beyond the specified Contract Completion date. The construction schedule shall include all non-working periods and appropriate allowances for inclement weather.
- d) The construction schedule shall reflect operational constraints, interim completion dates, and other scheduling requirements specified in the Contract.
- e) A delay for an activity shall be deemed to have occurred when the activity is not complete on its late finish date established by the construction schedule or it exceeds the specified number of Working Days or specified Completion Date for the Contract.

.03 The requirements for diagrams and bar charts are detailed below:

- a) The Contractor may select to submit initial and updated construction schedules in either logic diagram format with accompanying time scaled bar charts or time scaled linear diagrams.
- b) The Contractor shall select the activities so that the Work is identifiable and the progress of each activity can be determined. The Owner reserves the right to limit or increase the number of activities on the diagram.
- c) Each activity in the initial and updated construction schedules shall include a description of the operation and the number of Days allocated or actually used for it. When the duration of an activity is dependent on weather conditions, the number of Days allocated shall include an allowance for normal frequency of inclement weather. In addition, for Contracts which specify the number of Working Days for the Contract Time, the expected number of Working Days shall be shown for the activities on the critical path that may be subject to Working Day charges. When the activity has an associated tender item quantity, the approximate quantity shall also be shown.
- d) The construction schedule shall show the sequence and interdependence of all activities required to complete the Work under the Contract, including time for review of Working Drawings and mix design submissions, early start date, early finish date, and float times. All network connections used to create a logical schedule and the corresponding durations shall be shown. Activities on the critical path shall be identified clearly on the diagram.
- e) The time scale of the construction schedule may be divided into Days or weeks.

.04 The Contractor shall not be permitted to start work until a construction schedule, conforming to clause GC 7.01.07, Critical Path Schedule, is received by the Contract Administrator.

.05 If, for any reason, the Contractor cannot produce an acceptable construction schedule within 30 Business Days of initial submission of the construction schedule, the Contractor shall be in default of the Contract.

GC 7.01.08 Errors Relating to the Contract

.01 Where the Contractor finds any errors, inconsistency, or omissions relating to the Contract, the Contractor shall promptly report as a Request for Clarification to the Contract Administrator on Owner Standard Form PH-CC-750, Request for Clarification, and shall not proceed with the activity affected until receiving direction from the Contract Administrator.

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 be responsible for any damage done to the underground Utilities by the Contractor's forces during construction. The Contractor shall also be responsible for any damage done to the service connections. The Contractor shall attend such meetings with the Contract Administrator and the Utility authorities as may be required by the Contract Administrator to ensure coordination of activities among the Contractor and the Utility authorities for each Utility affected by the Contract.
- .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 and the Contract Administrator of the location and details of such damage or interference.

GC 7.01.10**Public Ceremony**

- .01 Only the Owner shall be permitted to make the first public announcements or hold the first public ceremonies about the award or acceptance of the Contract, project milestones, and Contract Completion. The Contractor shall not hold any public ceremony or make any public announcements about the above matters prior to the Owner doing so, without first obtaining the prior written approval of the Owner. The Contractor shall refer all media inquiries regarding such initial announcement and ceremonies to the Owner.

In the above paragraph "project milestones" means any significant event in the completion of the Work, which includes the completion of a major component of the Work; the opening or closing of lanes, ramps, and structures; and any Work associated with incentives and disincentives described in the Contract.

GC 7.02**Layout**

- .01 Prior to commencement of construction, the Contract Administrator and the Contractor shall locate on site those property bars and benchmarks that are necessary to delineate the Work Area and to lay out the Work, as shown on the Contract Drawings.
- .02 The Contractor shall be responsible for the preservation of all property bars while the Work is in progress, except those property bars that require removal to facilitate the Work. Any property bars disturbed, damaged, or removed by the Contractor's operations shall be replaced under the supervision of an Ontario Land Surveyor, at no cost to the Owner.
- .03 The Contractor shall provide qualified personnel to layout and establish all lines and grades necessary for construction. The Contractor shall notify the Contract Administrator of any layout work carried out.
- .04 The Contractor shall assume full responsibility for alignments, elevations, and dimensions of each and all parts of the Work.
- .05 All stakes, marks, and reference points provided by the Contract Administrator shall be carefully preserved by the Contractor. In the case of their destruction or removal, such stakes, marks, and reference points shall be replaced by the Contractor at no cost to the Owner.
- .06 The Contract Administrator shall provide a Grading Report to establish grading cross-sections. During the progress of the work the Contractor shall notify the Contract Administrator forthwith of any errors, omissions, or inconsistencies in the geometric information and the controls provided by the Owner. This report contains all necessary information relating to distance and elevation for each station necessary for the construction of the Work.

.07 Certification shall be required for the layout of the following components of the work:

- a) Bridges;
- b) Retaining walls;
- c) Culverts having a span of 5 m or more;
- d) Tunnelling, excluding augured tunnels;
- e) Sewers of 2 m diameter or more.

For each of the identified components above, the Contractor shall provide to the Contract Administrator, on Owners Standard Form PH-CC-811, Certification of the Component, over the seal and signature of either an Engineer or an Ontario Land Surveyor, the following:

- a) Certification of the final pile location before proceeding with footings.
- b) Certification that the footings have been constructed to the designated lines and grades before proceeding with any work above the footings.
- c) Final elevations of bridge seats and certification of span dimensions before proceeding with any work on the superstructure of each bridge.
- d) Actual profiles on the beams before proceeding with any work on the deck of each bridge.
- e) Certification of the final screed rail elevations before proceeding with the deck placement.
- f) Certification that each of the identified components of the Work has been constructed to the designated lines and grades before the Contract Completion Certificate.

.08 The Contractor shall supply the Owner with all as-constructed horizontal and vertical data related to the layout of the Work before the Contract Completion Certificate.

.09 The Contractor shall advise the Contract Administrator of the intended layout schedule at the weekly meeting by identifying the survey activities planned for the following week, including any miscellaneous surveying items.

.10 For the grading layout, stakes 25 x 50 x 600 mm, minimum, shall be installed left and right of centreline at or near the right-of-way limits and in the areas where additional staking is required, (e.g., intersections, bridges, and on horizontal and vertical curves). Staking intervals shall be as specified in Table 7.02-1 and Table 7.02-2. The only data to be shown on these stakes shall be profile grade, off-set distance from centreline, and station location. The Contractor shall erect butterfly rods or batter boards at grade stake locations.

.11 The Contractor shall provide a complete set of off-set stakes with finished grade and stations for the following components of the Work:

- a) Drainage Items

Sewers, road culverts, entrance culverts, manholes, and similar items.

b) Pavement Items

Concrete base, concrete pavement, stabilized base, asphalt, Pavement, and similar items. Fine grading stakes shall be used for this work when Pavement items form part of grading or granular work.

c) Miscellaneous Items

Sidewalk, curb and gutter, slope paving, structures, fencing, noise barrier, lighting, guide rail barrier, rip-rap, and similar items as required by the Owner.

- .12 For fine grading layout, including paving, fine grading stakes 25 x 50 x 600 mm in size shall be installed left and right of the control line at or near the Subgrade Shoulder break. These stakes shall be installed at an interval of 30 m or less where the Contract Administrator deems appropriate, on horizontal and vertical curves, widening of intersections, and similar locations. The only data to be shown on these stakes shall be Profile Grade, elevation, off-set distance from the control line, and station.
- .13 For resurfacing layout, offset stakes shall be installed left or right of the control line and at or near the edge of Shoulder at an interval of 50 m or less. The only data to be shown on the stake shall consist of the final Pavement elevation, off-set distance from the control line, and station.

GC 7.03 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, within or outside the Work Area, by the Contractor's vehicles or other Equipment, whether licensed or unlicensed, 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, alter loadings, or in some other manner, remove the cause of such damage to the satisfaction of the Contract Administrator.

GC 7.04 Excess Loading of Motor Vehicles

- .01 Where a vehicle is hauling Material, 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, 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.
- .02 Vehicles hauling Materials shall be accompanied by an Owners Standard Form SR-E-121, Record of Allowable Gross Weight certificate, on. The legal limit shall be the vehicle's registered gross weight or the allowable gross weight, whichever is less. The Contractor shall ensure that a copy of the Record of Allowable Gross Weight form is left with the weigh person for Owner use.

GC 7.05 Use of Construction Equipment and Unlicensed Vehicles

- .01 Unlicensed vehicles and construction equipment, with the exception of rock trucks, shall not travel, work, or stop within 4 m of a lane carrying traffic, except where construction operations necessitates the Working Area be less than 4 m from the traffic in which case, the Contractor shall erect delineators along the edge of the travelled lane, according to paragraph GC 7.08.01.
- .02 The use of unlicensed rock trucks on facilities open to public traffic shall be permitted only when hauling rock material within the construction zone and subject to the following:

- a) For unlicensed rock trucks that are less than 3.2 m wide and equipped with foot operated brakes, headlights, and front and rear turn signals, flagging is required at entrance and exit points to warn public traffic.
- b) For all other unlicensed rock trucks, flagging is required at entrance and exit points and either pilot vehicles or flagging is required along the route to warn public traffic and control movement.

GC 7.06 Carrier Safety Compliance

GC 7.06.01 Contractor Operation of a Commercial Motor Vehicle

.01 Where the Contractor is a Commercial Vehicle Operator's Registration (CVOR) Holder who intends to operate a Commercial Motor Vehicle in the performance of the Contract or in the haulage of Materials to, on, or from the Working Area, the Contractor shall provide to the Owner a copy of the Contractor's CVOR Abstract as follows:

- a) The first CVOR Abstract shall be provided to the Owner before the Contractor operates a Commercial Motor Vehicle in the performance of the Contract or in the haulage of Materials to, on, or from the Working Area, and
- b) CVOR Abstracts shall be submitted to the Owner:
 - i. Annually in October.
 - ii. Periodically upon request anytime during the period of the Contract.

The search date recorded on any CVOR Abstract shall not exceed 30 Days from the date that it is provided to the Contract Administrator.

.02 If at any time the Contractor holds an unsatisfactory or conditional CVOR rating, the Contractor shall advise the Contract Administrator within 72 hours:

- a) The Contractor's Commercial Motor Vehicles shall not operate in the performance of the Contract or in the haulage of materials to or from the Working Area while the Contractor holds an unsatisfactory CVOR rating.
- b) The Contract Administrator may permit a Contractor with a Conditional CVOR rating to operate their vehicles in the performance of the Contract or in the haulage of materials to or from the Working Area, subject to the following performance criteria:
 - i. Within 10 Days of having a Conditional CVOR Rating, the Contractor produces an approved plan confirming that drivers and vehicles safety programs are in place to ensure compliance with the safety rating requirement, the Highway Traffic Act and National Safety Code; and
 - ii. Achieve a satisfactory, satisfactory unaudited, or excellent safety rating under the MTO Carrier Safety Rating Program and have a violation rate of under 70% within 12 months of the date the plan is submitted to the Owner, or show improvement in the Carrier's Safety Performance over the term of the Contract by reducing the Carrier's pointable accidents, pointable convictions and out of service inspections.

Where a Contractor fails to achieve the performance criteria outlined above, the Contract Administrator may require the Contractor to subcontract all work requiring a CVOR Certificate and the Contractor's bidding privileges on future work with the Owner may be affected.

Provisions GC 7.06.01.02, b), i and ii, are in addition to any carrier interventions or sanctions imposed through the MTO CVOR program.

GC 7.06.02**Subcontractor and Other Operation of a Commercial Motor Vehicle**

- .01 Prior to any CVOR Holder operating a Commercial Motor Vehicle in the performance of the Contract or in the haulage of material to, on, or from the Working Area, the Contractor shall examine the CVOR Abstract of every CVOR Holder with whom the Contractor intends to subcontract, directly or indirectly, to operate a Commercial Motor Vehicle in the performance of the Contract or in the haulage of materials to, on, or from the Working Area. The Contractor shall provide the Contract Administrator with the CVOR Holder's name and CVOR Certificate number of all Subcontractors.

The search date of any CVOR Level 1 Abstract shall not exceed 30 Days from the date that it is provided to the Contractor.

The Contractor shall retain copies of all CVOR Abstracts for examination by the Owner, upon request.

- .02 The CVOR Holder shall not hold a dormant or inactive CVOR certificate at any time during the period of the Contract.

The Contractor shall, at all times throughout the duration of the Contract, ensure that no CVOR Holder with an unsatisfactory CVOR rating works, directly or indirectly, for the Contractor in the operation of a Commercial Motor Vehicle in the performance of the Contract or in the haulage of materials to, on, or from the Working Area. The Contractor shall require Subcontractors, in turn, to require compliance with subsection GC 7.06, Carrier Safety Compliance, from any Person with whom they contract.

If a CVOR Holder holds an unsatisfactory CVOR rating at any time during the period of the Contract, the Contractor shall inform the Contract Administrator, in writing, within 72 hours of becoming aware, having exercised all due diligence, of such CVOR Holder having an unsatisfactory CVOR rating.

The Contract Administrator may permit a Subcontractor with a conditional CVOR rating to operate their vehicles subject to the following:

- a) Within 10 Days of having a conditional CVOR record, the Subcontractor produce an approved plan confirming that drivers and vehicles safety programs are in place to ensure compliance with the safety rating requirement, the Highway Traffic Act and National Safety Code; and
- b) Achieve a satisfactory, satisfactory unaudited, or excellent safety rating under the ministry's Carrier Safety Rating Program and have a violation rate of under 70% within 12 months of the date the plan is submitted to the Owner, or show improvement in the Carrier's Safety Performance over the term of the contract by reducing the Carrier's pointable accidents, pointable convictions, and out of service inspections.

Where a Subcontractor fails to achieve the performance criteria above the Contractor shall within 1 month replace the Subcontractor or CVOR Holder and the Contractor's bidding privileges on future work with the Owner may be affected.

Provisions GC 7.06.02.02, a), and GC 7.06.02.02, b), are in addition to any carrier interventions or sanctions imposed through the MTO CVOR program.

GC 7.07**Condition of the Working Area**

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

- .02 During night work, the Contractor shall ensure that the worksite is adequately illuminated to the Contract Administrator's satisfaction for work operations and inspections and the advance warning to traffic.
- .03 The Contractor shall take such steps as may be necessary to control dust resulting from the Contractor's operations or by public traffic, where it is the Contractor's responsibility to maintain a road through the Work, 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.

GC 7.08 Maintaining Roadways and Detours

- .01 Where an existing Roadway is affected by construction, it shall be kept open to traffic, and the Contractor shall, except as otherwise provided in subsection GC 7.08, Maintaining Roadways and Detours, be responsible for providing and maintaining a road through the Work for the duration of the Work, whether along an existing Highway, including the road under construction, or on detours within or adjacent to the Highway according to the OTMs.
- .02 The Contractor shall not be required to maintain a Roadway through the Working Area before the Contractor has commenced the Work, or during seasonal shutdown or within any sections of the Roadway where a twelve (12) month general warranty period has commenced. Responsibility for maintenance shall be transferred between the Contractor and the Owner at the commencement of the Work, the start and end of each seasonal shutdown period, and the start of each twelve (12) month general warranty period. A minimum of 5 Business Days prior to an anticipated transfer date of responsibility for maintenance, the Contract Administrator, Contractor and a representative of the Owner's maintenance contractor shall perform a pre-turnover field inspection. The pre-turnover field inspection shall identify deficiencies within the right-of-way and the anticipated timeframe for correction. The Contract Administrator shall be the sole judge of whether or not the noted deficiencies require correction prior to or after the turnover date. Provided that the Contractor was given advance written notice of the pre-turnover inspection date, the Contractor shall not delay commencement of the Work or the assumption of responsibility for maintenance because of the existence of deficiencies. A Turnover Agreement Form PH-CC-771, prepared by the Contract Administrator, which identifies the date and time that responsibility for maintenance shall be transferred between parties shall be executed by both the Contract Administrator and Contractor prior to the actual turnover date. 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. The Contractor shall not be required to apply deicing chemicals or abrasives or carry out snow-plowing on a public road.
- .03 The Contractor shall ensure that the Roadway affected by construction is clear of debris. All debris on the travelled portion of the Roadway shall be removed as soon as possible after detection. Debris on the Shoulder shall be removed within 24 hours.
- .04 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.
- .05 The Owner shall bear the cost of maintaining, in a satisfactory condition for public traffic, a Roadway through the Working Area. The Contractor shall bring any defects to the attention of the Contract Administrator as soon as they are identified. Such defects include potholes, distortions,

pavement edge loss, washouts, drop-offs, and soft or wet areas. Compensation for all labour, Equipment, and Materials to address such defects 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 providing an operated grader, required to maintain the surface of such Roadways, shall be deemed to be included in the prices bid for the various tender items and no additional payment shall be made.

- .06 Compliance with the foregoing provisions shall in no way relieve the Contractor of obligations under subsection GC 6.01, Protection of Work, Persons, and Property, dealing with the Contractor's responsibility for losses and damage.
- .07 The Contractor shall ensure that earth, mud, aggregate, and other construction debris are not tracked onto the Roadway by construction vehicles.

GC 7.09 Access to Properties Adjoining the Work and Interruption of Utility Services

- .01 At all times, the Contractor shall provide the following to properties adjoining the Working Area at no additional cost to the Owner:
 - a) Pedestrian and vehicular access; and
 - b) Continuity of Utility services.
- .02 At all times, the Contractor shall provide access to fire hydrants and water and gas valves located in the Work Area at no additional cost to the Owner.
- .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 according to subsection GC 7.13, Notices by the Contractor, and shall arrange such interruptions so as to create a minimum of interference to affected property owners.

GC 7.10 Approvals and Permits

- .01 Except as specified in paragraph GC 7.10.02, the Contractor shall obtain any permits, licenses, and certificates required for the performance of the Work that are in force at the date of tender closing.
- .02 The Owner shall obtain and pay for the necessary plumbing and building permits.
- .03 The Contractor shall arrange for all necessary inspections.

GC 7.11 Suspension of Work

- .01 The Contractor shall, upon written notice from the Contract Administrator, discontinue or delay any or all of the Work. The Work shall not resume until the Contract Administrator issues such written direction. Delays, in these circumstances, shall be administered according to subsection GC 3.07, Delays.

GC 7.12 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 terminate the Contract, without prejudice to any other right or remedy the Contractor may have, by giving the Owner or receiver or trustee in bankruptcy written notice.

- .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 any Person directly employed or engaged by the Contractor, the Contractor may terminate the Contract, without prejudice to any other right or remedy the Contractor may have, by giving the Owner written notice.
- .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 payment certificates according to the provisions of section GC 8.0, Measurement and Payment;
 - b) The Owner fails to pay the Contractor, within 30 Days of the due date, the amounts certified by the Contract Administrator or awarded by arbitration or court;
 - c) The Owner fails to comply with the requirements of the Contract to a substantial degree.
- .04 The Contractor's written notice to the Owner shall advise that if the default is not corrected in the 7 Days immediately following the 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 7.12, 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 7.13 Notices by the Contractor

GC 7.13.01 Advance Notice

- .01 Before any or all of the Work is carried out that may affect the property or operations of any owner or agency of government or any individual, 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 Document, the Contractor shall give at least 48 hours advance written notice of the date of commencement of such work to the individual person, company, partnership, corporation, board, or commission so affected.

GC 7.13.02 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
 - b) *Fisheries Act* (R.S., 1985)
 - c) *Technical Standards and Safety Act*, 2000
 - d) *Pesticides Act*, R.S.O. 1990
 - e) *Ontario Water Resources Act*, R.S.O. 1990
 - f) *Transportation of Dangerous Goods Act*, 1992

- .02 The requirements of the legislation listed in paragraph of GC 7.13.02.01 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) Cleanup 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 paragraphs GC 7.13.02.01 and GC 7.13.02.02.
- .04 The Contractor shall also be responsible for informing the Contract Administrator forthwith 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 Within 48 hours of an Environmental Incident, the Contractor shall provide to the Contract Administrator, on Owner Standard Form PH-CC-818, Environmental Incident Notification Form, details of such incident.
- .06 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 paragraph GC 7.13.02.01.

GC 7.14 Obstructions

- .01 Except as otherwise noted in these MTO General Conditions of Contract, 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 such as a telephone cable, watermain, gas main or sewer 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 specifications and the location so shown is within the tolerance specified in paragraph 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 according to these MTO General Conditions of Contract.
- .03 During the course of the Contract, it is the Contractor's responsibility to consult with Utility companies or other appropriate jurisdictions 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 7.15 Limitations of Operations

- .01 Except for such work as may be required by the Contract Administrator to maintain the Working Area in a safe and satisfactory condition, the Contractor shall not carry on operations under the Contract on Sundays without permission in writing from the Owner.

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

GC 7.16 Cleaning Up Before Contract Completion

- .01 Upon attaining Substantial Performance of the Work, the Contractor shall remove surplus materials, Hand Tools, 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 shall 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 Contract Completion until the Contractor has removed surplus materials, Hand Tools, Equipment. The Contractor shall also have removed debris, other than that caused by the Owner or others.

GC 7.17 Record Drawings

- .01 The Contractor shall provide 3 hard copies and 1 digital file, in PDF format, of Record Drawings prior to Contract Completion.
- .02 Record Drawings shall show all differences, design changes, and deviations from the original Contract Drawings in red with references to the Contractor's survey and quality control inspection records beside each entry.

GC 7.18 General Warranty

- .01 Unless otherwise specified in the Contract 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 specifications permit such performance. The onus is on the Contractor to show through engineering analysis that the design and specifications are deficient for the proper performance of the Work.
- .02 Subject to the previous paragraph, the Contractor shall correct promptly at no cost to the Owner, defects or deficiencies in the Work that appear during the period of 12 months after the date of Substantial Performance as set out in the Certificate of Substantial Performance or such longer periods as may be specified for certain Materials or components of the Work. The Owner shall promptly give the Contractor written notice of observed defects or deficiencies. The Contractor shall submit a comprehensive repair proposal, including traffic control measures, to the Owner within 15 Days of receiving written notification of the defects or deficiencies.

Notwithstanding the above, on Contracts lasting more than 1 construction season, the Owner shall allow the 12 month general warranty period to commence prior to the date of Substantial Performance for complete sections of Roadways that have been completed in their entirety, have a value of greater than \$5,000,000, and are in use by public traffic. In such cases, the Contractor shall apply in writing to the Owner for approval of the start dates of the general warranty for the selected sections of completed Roadways. The written request shall be submitted to Contract Administrator no later than 10 Days prior to the proposed general warranty start dates and include details as to the limits, location, and start date requested. If a request is granted, the Contractor shall correct promptly at no cost to the Owner, defects or deficiencies in the completed section of Roadway, which appear during the period of 12 months after the date of commencement of the warranty on the completed section of Roadway

- .03 The Contractor shall correct or pay for damage resulting from corrections made under the requirements of paragraph GC 7.18.02.

GC 7.19 Accounts Payable

- .01 The Contractor shall pay interest after 30 Days on accounts payable to the Owner at the Rate of Interest.

SECTION GC 8.0 - MEASUREMENT AND PAYMENT

GC 8.01 Measurement

GC 8.01.01 Quantities

- .01 Quantities for progress payments shall be construed and held to be approximate. The final quantities for the issuance of the Contract Completion Certificate shall be based on the measurement of the Work completed.
- .02 Measurement of the quantities of the Work shall be either by Actual Measurement or by Plan Quantity as indicated in the Contract. Adjustments to Plan Quantities shall normally be made by modifying boundary lines and grades of the work on the plans to calculate new adjusted Plan Quantities 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 When it appears that the quantity of work to be done or Material to be supplied by the Contractor or both 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 Materials supplied or both at the unit prices stated in the tender except as provided below:
- a) In the case of a Major Item, when the quantity of work performed or Material supplied by the Contractor or both 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.
 - b) In the case of a Major Item, when the quantity of work performed or Material supplied by the Contractor or both is less than 85% of the tender quantity, the Contractor may make a written request to negotiate payment for the portion of 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 shall be received no later than 180 Days after Contract Completion.
- .02 When it appears that the amount of work to be done or Material to be supplied by the Contractor or both under a lump sum concrete item may exceed or be less than the amount shown in the Contract Documents, 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 on the basis of the lump sum price shown in the tender except as provided below:
- a) Where the theoretical quantity as determined from the design dimensions of the structure components exceeds the estimated quantity of concrete stated in the Contract Documents by more than 3% and when such increase does not result from a change in design made according to paragraph GC 3.10.01.01, then the Contractor may make a written request to the

Contract Administrator to negotiate the compensation payable for that portion of the concrete that exceeds 103% of the estimated quantity. The negotiation shall be carried out as soon as reasonably possible. Any increase in the compensation shall be based on the actual cost of supplying and placing that portion of the concrete which exceeds 103% of the estimated quantity plus a reasonable allowance for profit and overhead.

- b) Where the theoretical quantity as determined from the design dimensions of the structure components is less than 97% of the estimated quantity of concrete stated in the Contract Documents and where such difference does not result from a change in design made according to paragraph GC 3.10.01.01, then the Contract Administrator may make a written request to the Contractor to negotiate the compensation payable for the item to reflect the change in quantity. The negotiation shall be carried out as soon as reasonably possible. Any decrease in compensation shall be based on the estimated value of the amount of underrun in excess of 3% of the estimated quantity and shall include a reasonable allowance for profit and overhead.

- .03 The Contractor or the Contract Administrator may dispute the quantity that is specified for payment on a Plan Quantity basis. The dispute shall be supported by calculations, drawings, and any other evidence indicating why the Plan Quantity is believed to be in error. If the Plan Quantity is found to be in error, payment shall be made according to the adjusted Plan Quantity.

GC 8.02 Payment

GC 8.02.01 Non-Resident Contractor

- .01 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 non-resident in Ontario have obtained all necessary approvals, consents, permits, licences, 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 to do the work. The term "all labour, Equipment, and Material" shall include Hand Tools, supplies, and other incidentals.
- .02 Payment for Work as shown or detailed in the Contract Documents not specifically detailed as part of any one item and without specified details of payment shall be deemed to be included in the item with which it is associated.
- .03 Payment adjustments determined according to the Contract Documents shall be applied to the payment due to the Contractor.

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) In advance of receipt of the shipment of the Material, the Contractor shall, arrange for adequate and proper storage facilities and notify the Contract Administrator of the location of the 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, and M shall be assessed at the rate of 60% of the tendered unit price.
 - (B) Coarse and fine aggregates for hot mix asphalt and surface treatment shall be assessed at the rate of 25% of the tendered unit price multiplied by the tonnage of each Aggregate in stockpile. Prior to payment, the Contractor shall provide test results and mix designs to demonstrate that the materials are capable of producing a mix design conforming to the Contract Documents.
 - ii. Commercial Sources

Payment for separated coarse and fine aggregates shall be considered at the same rate as sources other than commercial, when such Materials are stockpiled at a commercial source. Advance payments for other materials located at a Commercial Source shall not be made.
- c) Payment for all other Materials, unless specified otherwise elsewhere in the Contract Documents, shall be based on an invoice identifying the Contract and marked as "paid" and signed by the Material supplier. In the event of Materials supplied by a Subcontractor, the Contractor shall provide the original Material supplier invoice marked as paid and signed by the Material supplier and an invoice from the Subcontractor marked as paid and signed by the Subcontractor.
- 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 tendered unit 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 of the Contract Administrator, in writing. The Contractor shall arrange for a lease agreement with any private property owner where such Material is to be stored on Owner Standard Form PH-CC-733, Owner Tenancy and Access Agreement, granting the Owner tenancy and access for any storage location on private property for the sum of \$1.
- 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 so caused.

GC 8.02.04 Certification and Payment

GC 8.02.04.01 Progress Payment Certificate

- .01 The Contractor shall submit an application for progress payment monthly after starting the Work on this Contract. This application for progress payment shall be for work completed at the agreed to monthly cut-off date.

Within 5 Business Days following the agreed to monthly cut-off dates, the Contractor shall submit an updated application to the Contract Administrator.

The application shall contain two parts:

Part 1 - Invoice detailing:

Item numbers, description, unit of measurement, original tender quantity, approved revised quantity, total quantity to date, quantity previous invoice, quantity this period, unit price, dollars this period, and total dollars to date.

Subtotals shall be detailed for tender items, Change Orders, incentives, disincentives, and quality assurance Material bonuses or penalties.

The item information appearing on the invoice shall agree exactly with those as shown in the bid tender document.

Part 2 - Quantity Sheets detailing:

Item numbers, sub-item numbers, unit of measurement, location description, original tender quantity, approved revised quantity, total quantity to date, quantity previous invoice, and quantity this period.

The item information appearing on the Quantity Sheets shall agree exactly with those provided in the bid tender document. The Quantity Sheet information shall be sufficient to allow the Contract Administrator to verify and approve the invoice for payment.

Invoices and Quantity Sheets shall be submitted in hard-copy and digital format. The Contract Administrator shall review the invoice for completeness and subsequent approval for payment within 5 Business Days.

The Owner shall pay the approved invoice within 30 Days after the application for progress payment date or after the date of receipt of any invoice that had to be resubmitted due to deficiencies, errors, or non-compliance with the Owner's request in the preceding paragraphs.

The Owner shall not process for payment any changes less than \$1,000 from the amount shown on the previous payment certificate.

GC 8.02.04.02 Payment Adjustment for Changes in the Fuel Price Index

- .01 The Owner shall adjust the payment to the Contractor based on changes to the Owner's fuel price index. The fuel price index shall be calculated by the Ministry of Energy, Science, and Technology, and shall be based on the rack price, including taxes, of diesel fuel. The fuel price index shall be published monthly in the Owner's Contract Bulletin for each calendar month and shall reflect the previous month's prices. The Contractor shall use this index when calculating flow through to truckers, Subcontractors, and shippers and suppliers.
- .02 A payment adjustment, excluding any payments for Changes in the Work and Additional Work, shall be calculated monthly and applied to the monthly progress payment.
- .03 It is agreed by the parties to the Contract that it is impracticable and difficult to ascertain actual fuel consumed on the Contract, and the parties hereto agree that for the purpose of calculating the total fuel price adjustments, the amount of fuel consumed shall be determined using the rates in Table 8.02.04.02-1. The payment provided for the items listed in Table 8.02.04.02-1 shall be deemed to be for all Work.

- .04 Payments provided under clause GC 8.02.04.02, Payment Adjustment for Changes in the Fuel Price Index, shall be used to compensate all trucks, Subcontractors, and shippers and suppliers performing any Contract Work or delivering material for the Contract including items not listed in Table 8.02.04.02-1.
- .05 The compensation provided through this provision shall also be used for the purpose of providing fuel price adjustment compensation to suppliers and shippers. Should the Contractor be required by a supplier to negotiate and provide fuel price adjustment compensation to any party providing Materials to the Contract, the Owner shall not provide any compensation for this purpose in addition to that provided through these MTO General Conditions of Contract.
- .06 Fuel Price Adjustment Calculation
- a) The Contractor's payment adjustment for each month shall be calculated using the following formula:
- $$Cfpa = (Ctem) \times \frac{(I - Bc)}{100}$$
- Where:
- Cfpa = fuel price adjustment paid to Contractor or Owner, in dollars
- Ctem = total estimated monthly fuel consumption
- I = progress payment month fuel price index (for the month that the work was completed in)
- Bc = fuel price index in the month that the Contract was advertised for tender
- b) The progress payment month fuel index shall be published the first Friday of every month in the Owner's Contract Bulletin.
- c) The total monthly fuel consumption shall be calculated by multiplying the consumption rates in Table 8.02.04.02-1 by the work accomplished in the current month for each applicable item and totalling the volume in litres.
- d) Only tender item quantities or work done at the tender item price shall be included in the calculation.
- .07 Payment Certificate Documentation
- a) When (I-Bc)(progress payment month fuel price index – advertising month fuel price index) is positive, the Contractor shall receive a payment.
- b) When (I-Bc)(progress payment month fuel price index – advertising month fuel price index) is negative the Owner shall receive a credit.
- c) The Contractor shall show the fuel price adjustment as a line item on each progress payment certificate and the final payment certificate. The item shall be called fuel price adjustment.

.08 Fuel Price Adjustment Flow Through

- a) The Contractor agrees to adjust the payment to each trucker hired directly by the Contractor for execution of part of the Work according to the following formula:

$$Tfpa = (Tmpp) \times \frac{(I - Bt)}{Bt} \times 0.17$$

Where:

Tfpa = fuel price adjustment paid to trucker, in dollars

Tmpp= monthly payment to trucker, in dollars

Bt = fuel price index in the month that the Contract with the trucker was entered into either verbally or in writing

I = progress payment month fuel price index (for the month that the work was completed in)

The fuel price adjustment paid to each trucker (Tfpa) shall be calculated for each calendar month and may be positive or negative.

- b) The Contractor agrees to adjust the payment to each Subcontractor according to the following formula:

$$Sfpa = (Smpp) \times \frac{(I - Bs)}{Bs} \times \frac{Fn}{100}$$

Where:

Sfpa = fuel price adjustment paid to the Subcontractor, in dollars

Smpp= monthly progress payment to the Subcontractor, in dollars

Bs = fuel price index in the month that the Contract with the Subcontractor was entered into either verbally or in writing

I = progress payment month fuel price index (for the month that the work was completed in)

Fn = fuel consumption factor as negotiated between the Contractor and the Subcontractor as a percentage of the value of the subcontract

- c) The Contractor shall report the negotiated fuel consumption factor (Fn) on Owner Standard Form PH-CC-744 Fuel Consumption Listing Subcontractor, listing all subcontracts, and the corresponding negotiated fuel consumption factor. The form shall be updated monthly or as changes and additions arise.
- d) The Contractor also agrees that each subcontract shall contain a requirement that the Subcontractor shall make a fuel price adjustment to each trucker hired directly by the Subcontractor for execution of part of the work according to the same formula and conditions used by the Contractor to make fuel price adjustments to truckers, and provide such confirmation on Owner Standard Form PH-CC-745 Fuel Consumption Tracking Subcontractor, for each trucker.

GC 8.02.04.03 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 the subcontract.
- .02 The Contract Administrator shall issue on Owner Standard Form PH-CC-797, Certificate of Completion of Subcontract, if the subcontract has been completed satisfactorily and all required inspection and testing of the work covered by the subcontract have been carried out and the results are satisfactory.
- .03 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 8.02.04.04 Subcontract Statutory Holdback Release Certificate and Payment

- .01 At the time of issuance of the Certificate of Completion of Subcontract, the Contract Administrator shall:
 - a) Prepare a subcontract completion payment certificate showing:
 - i. The final prices for items;
 - ii. The amount of holdback monies;
 - iii. The amount due the Contractor.
 - b) Mail to the Contractor, the subcontract completion payment certificate within 50 Days of the date the subcontract was certified complete, for the Contractor to sign and return within 25 further Days. The Contract Administrator shall release to the Subcontractor through the Contractor the 10% holdback retained by the Owner in respect of the work covered by the said subcontract after it is certified complete and providing that all lien claims have been discharged and providing that the Contractor has furnished to the Contract Administrator a statutory declaration in a form supplied by the Owner that the said Subcontractor has discharged all liabilities incurred by the Subcontractor in carrying out the said subcontract.
- .02 Payment of the holdback monies by the Owner shall be made within a period of 105 Days from the date on which the subcontract was certified complete, providing the Contractor returns the said certificate within the required time.
- .03 On receipt of the holdback monies from the Owner, the Contractor shall forthwith pass the payment due under the said subcontract to the Subcontractor concerned.
- .04 Release of holdback monies by the Owner in respect of a subcontract according to the foregoing shall not relieve the Contractor or the Contractor's surety of any of their responsibilities.

GC 8.02.04.05 Certificate of Substantial Performance

- .01 Application for Substantial Performance by the Contractor shall be submitted in the form of a letter, accompanied with:
 - a) An application for payment at Substantial Performance in a form satisfactory to the Contract Administrator for all work to date, the amount of the 10% holdback, and the amount due.
 - b) A release, on Owner Standard Form PH-CC-817, Application for Substantial Performance/Contract Completion, by the Contractor releasing the Owner from all further claims related to the Contract qualified by stated exceptions such as outstanding work or matter arising out of subsection GC 3.14, Clarification and Claims.

- c) A statutory declaration, on Owner Standard Form PH-CC-817, Application for Substantial Performance/Contract Completion, that all liabilities incurred by the Contractor and the Subcontractors in carrying out the Contract have been discharged except for the statutory holdbacks properly retained.
 - d) A satisfactory Certificate of Clearance from the Workplace Safety and Insurance Board.
- .02 Upon written application by the Contractor for Substantial Performance, the Contract Administrator shall conduct an inspection of the Work to establish the date of Substantial Performance of the Work. The Contractor's application shall detail non-conformances, defects to be rectified, and work yet to be completed. The Contract Administrator shall provide a list of deficiencies and work yet to be completed in addition to the Contractor's list. The Contractor's list of non-conformances, defects, and works yet to be completed together with the Contract Administrator's list of same shall be combined and referred to as the Substantial Performance deficiency list. All deficiencies and work to be completed from the Substantial Performance Deficiency List shall be completed prior to Contract Completion. Any additional defects and deficiencies for work previously accepted as substantially performed shall be completed within 60 Days of Contract Completion, unless prevented by winter weather conditions; in such case, the defects and deficiencies shall be corrected by June 15th of the following year. Defects and deficiencies on work completed after Substantial Performance shall be completed prior to Contract Completion.
 - .03 Upon verifying that the Contract has been substantially performed, the Contract Administrator shall issue a Certificate of Substantial Performance and shall set out in the Certificate of Substantial Performance the date on which the Contract was substantially performed and within 7 Days after the signing the said certificate the Contract Administrator shall provide a copy to the Contractor.
 - .04 Upon receipt of a copy of the Certificate of Substantial Performance, the Contractor shall arrange to have the certificate published in the *Daily Commercial News* and the Contractor shall provide to the Contract Administrator proof that the certificate was published. Where the Contractor fails to publish a Certificate of Substantial Performance within 7 Days of receiving the certificate, the Owner may publish the certificate in the *Daily Commercial News* and charge the Contractor \$400 for the costs of advertising and administration. The 45-Day lien period shall start on the date the Certificate of Substantial Performance is published in the *Daily Commercial News*.
 - .05 Except as otherwise provided for in Section 31 of the *Construction Lien Act*, the 45-Day lien claim period prior to the release of holdback shall commence from the date of publication of the Certificate of Substantial Performance as provided for in paragraph GC 8.02.04.05.04.

**GC 8.02.04.06 Substantial Performance Payment and Statutory Holdback Release
Payment Certificates**

- .01 Upon receipt of the application for payment at Substantial Performance, the Contract Administrator shall check the invoice and advise the Contractor of any discrepancies. Any of these discrepancies that are unresolved prior to the expiry of the 45-Day lien period shall be treated as set-offs.
- .02 If there are no outstanding lien claims, the Owner shall issue payment, without holdback on the work done, exclusive of the set-offs, within 30 Days after the expiration of the 45-Day lien period.
- .03 In addition to set-offs, holdback is accrued at the rate of 10%, on all work performed after the date of the application for payment at Substantial Performance.
- .04 If this Contract extends over more than one construction season and there are no outstanding lien claims, the Owner shall issue payment to reduce the holdback on work done from 10% to 2½%, plus the amount of the Owner's set-offs, not more than 5 Days after January 31st in each calendar year the Contract extends, provided that the Contract had not been substantially performed and the estimated value of the work performed is greater than 60% of the original tender value for a

contract having an expected duration of two construction seasons or less, or 40% for a Contract having an expected duration of more than two construction seasons.

GC 8.02.04.07 Certificate of Contract Completion

- .01 Application for Contract Completion may be requested by the Contractor once all services and Material required by the Contract have been supplied, exclusive of any warranties, and shall be submitted in the form of a letter, accompanied with:
 - a) An application for payment at Contract Completion in a form satisfactory to the Contract Administrator for all work to date, the amount of the 10% holdback, and the amount due the Contractor.
 - b) A release, on the Owner's Standard Form PH-CC-817, Application for Substantial Performance/Contract Completion, by the Contractor to the Contract Administrator releasing the Owner from all further claims related to the Contract qualified by stated exceptions (e.g., outstanding submissions or matters arising out of subsection GC 3.14, Clarifications and Claims).
 - c) A statutory declaration, on Owner Standard Form PH-CC-817, Application for Substantial Performance/Contract Completion, by the Contractor to the Contract Administrator that all liabilities incurred by the Contractor and Subcontractors in carrying out the Contract have been discharged, except for the statutory holdbacks properly retained.
 - d) A satisfactory Certificate of Clearance from the Workplace Safety and Insurance Board.
- .02 Upon confirming the Contract is complete, the Owner shall issue a Certificate of Contract Completion on the Owners Standard Form PH-CC-890 Certificate of Contract Completion and shall set out in the form the date on which the Contract was completed (date of Contract Completion) and within 7 Days after the signing the said certificate, the Owner shall provide a copy to the Contractor. A Certificate of Substantial Performance shall also be provided, if not previously requested by the Contractor.
- .03 If the Contractor has not previously received a Certificate of Substantial Performance, upon receipt of a copy of the Certificate of Contract Completion and the Certificate of Substantial Performance, the Contractor shall arrange to have the Certificate of Substantial Performance published in the *Daily Commercial News* and the Contractor shall provide to the Contract Administrator proof that the certificate was published. Where the Contractor fails to publish a Certificate of Substantial Performance within 7 Days of receiving the certificate, the Owner may publish the certificate in the *Daily Commercial News* and charge the Contractor \$400 for the costs of advertising and administration. The 45-Day lien period shall start on the date the certificate is published in the *Daily Commercial News*.
- .04 The Certificate of Contract Completion may be issued although not all required Contractor submissions have been provided. The Contractor shall provide all outstanding submissions (e.g., test results, Record Drawings, and manuals) within 20 Business Days of the date of Certificate of Contract Completion. It is anticipated the Owner shall incur damages after such time should the submissions not be received within the above time. The parties agree that liquidated damages of \$400 per Day shall be charged to the Contractor for each Day after 20 Business Days of the date of Certificate of Contract Completion until all submissions have been received.
- .05 Upon receipt of the application for payment at Contract Completion, the Contract Administrator shall check the invoice and advise the Contractor of any discrepancies. Any of these discrepancies that are unresolved prior to the expiry of the 45-Day lien period may be treated as a set-off.

- .06 Upon conclusion of the 45-Day lien period, and provided no liens have been received, all remaining holdback, exclusive of set-offs, shall be paid by the Owner, within 30 Days.

GC 8.02.04.08 Interest

- .01 Interest due the Contractor is based on simple interest and is calculated using the applicable Rates of Interest.

GC 8.02.04.09 Interest for Late Payment

- .01 When the Contractor has complied with the requirements of the Contract and 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 payment for Work performed at the Rates of Interest from a date or dates derived from the following:
- a) Progress payment due date: a date 30 Days after the cut-off date;
 - b) Subcontract completion and subcontract statutory holdback: a date 75 Days after the date the subcontract is certified complete;
 - c) Substantial Performance and statutory holdback: a date 75 Days after the date the Certificate of Substantial Performance is published;
 - d) Contract Completion and holdback: a date 75 Days after the date the Contract is certified complete.

GC 8.02.04.10 Interest for Clarifications and Claims

- .01 Except as hereinafter provided, where a Request for Clarification and any subsequent Claims are submitted according to the time limits and/or procedure described by section GC 3.14, Clarification and Claims, the Owner shall pay the Contractor the Rates of Interest on the amount of the negotiated price for the Work or on the amount of the settled Claim. Such interest shall commence from a date 30 Days next following the established cut-off date which immediately follows the completion of the Work to which the negotiation applies.

GC 8.02.04.11 Owner's Set-Off

- .01 Pursuant to Section 12 of the *Construction Lien Act* - Set-Off by Trustee, the Owner may retain from monies owing to the Contractor under this or any other 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 under paragraph GC 8.01.02, a), and any assessment due the Workers' Compensation Board.
- .02 Under these circumstances the Owner shall give the Contractor appropriate notice of such action.

GC 8.02.04.12 Contract Completion and Statutory Holdback Release Payments

- .01 Payment for subcontracts certified complete, including release of holdback shall be made within 105 Days of the date on which the Work was certified complete.
- .02 Payments for Work certified as substantially performed, including release of holdback, shall be made within 120 Days of the date of publication of substantial performance. The Owner shall reduce the holdback to 2½% at the end of the 45-Day lien period providing all liens are discharged. This payment shall be made within 30 Days of the expiry of the 45-Day lien period.

- .03 Final payment including release of holdback shall be made within 105 Days of the date of Contract Completion. Where the Contractor does not apply for Substantial Performance, final payment including release of holdback shall be made within 120 Days of the date of publication of Substantial Performance. In this case the Owner shall reduce the amount of holdback held to 2½% at the end of the 45-Day lien period providing all liens are discharged. This payment shall be made within 30 Days of the expiry of the 45-Day lien period.
- .04 The time periods stated in clause GC 8.02.04.12, Contract Completion and Statutory Holdback Release Payments, are all dependent on the Contractor returning the appropriate documents within the time stipulated in paragraph GC 8.02.04.07.04.

GC 8.02.04.13 Liens Filed Late

- .01 In cases where a lien is not preserved (i.e., the claimant files a claim outside the time limits prescribed in the *Construction Lien Act*), the Owner shall record the claim as an "out of time" lien. The Owner shall set-off the amount of the claim but only to the extent of the funds already held by the Owner with respect to the work which the claim has been filed against.
- .02 In cases where a lien has been preserved within the time allowed, but not perfected according to the *Construction Lien Act*, the Owner shall continue to hold the amount of the claim; however, the 25% security for costs held when the lien was preserved shall be released and included in the Contract payment.
- .03 The Owner shall be responsible for the final disposition of funds withheld under the circumstances noted in paragraphs GC 8.02.04.13.01 and GC 8.02.04.13.02.

GC 8.03 Payment on a Time and Material Basis

GC 8.03.01 Definitions

For the purpose of subsection GC 8.03, Payment on a Time and Material Basis, the following definitions apply:

Actual Payroll Burden means the payments in respect of the following list of items. No other items shall be permitted in the calculation of the Contractor's Actual Payroll Burden.

- a) **Vacation** means the Contractor's paid time off for vacation earned in each year calculated at salary cost, including overtime, according to the Contractor's policy.
- b) **Sick Leave** means the Contractor's paid time off due to sickness, accident, or injury or specific personal and family issues such as bereavement leave, jury duty, and similar leaves. Such paid time off is according to Contractor's policy and calculated at salary cost.
- c) **Statutory Holidays** means the Contractor's paid time off according to Ontario law and established custom.
- d) **Training** means the Contractor's paid time for employees to maintain and increase their level of skills pertaining to their position.
- e) **Employment Insurance** means the Contractor's portion of employment insurance premiums incurred according to the Employment Standards Act.
- f) **Group Life Insurance** means the premium paid by the Contractor to employee group life and short and long term disability insurance plans.

- g) **Employer Health Tax** means the premium incurred by the Contractor for the year according to the Employer Health Tax Act of Ontario.
- h) **Group Medical Plan** means the premium paid by the Contractor for group health insurance plans providing coverage of health care costs not covered by the basic government health plan.
- i) **Workplace Safety and Insurance Board** means the WSIB premium incurred by the Contractor for the year according to Workplace Safety and Insurance Act.
- j) **Contractor Pension Plan** means the Contractor's pension plan cost, including the cost of funding the pension benefits earned by employees and cost of services of third parties incurred for the pension plan.
- k) **Canada Pension Plan** means the Contractor's portion of Canada pension plan contribution incurred according to the Canada Pension Plan Act or its equivalent for non-residents.
- l) **Union Contributions** means the premium paid by the Contractor to a union according to active collective agreements. Items such as Industry Funds paid to a Trustee and Legal Benefits identified in such agreements are to be included under this item.

Cost of Labour means the amount of wages, salary, travel expenses, travel time, room and board, and Actual Payroll Burden paid or incurred directly by the Contractor to or in respect of labour and supervision actively and necessarily engaged on the Work on a Time and Material Basis 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, or management time spent on the entire Work or on any wages, salary, or Actual Payroll Burden for which the Contractor is compensated by any payment made by the Owner for Equipment.

Travel expenses, travel time, and room and board shall be justified by the Contractor and, if requested, the Contractor shall supply the Owner with proof of the expenditure. Reasonable costs for room and board shall only be paid if the Work on a Time and Material Basis extends the time that the Contractor's labour is on-site or if the Contractor hires labour that is not normal to the Contract and room and board is charged.

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 Work on a Time and Material Basis by the Contractor or by others when such arrangements have been made by the Contractor for completing the Work on a Time and Material Basis, as shown by itemized invoices.

Mark-Up means the amount of administrative overhead and project overhead costs incurred by the Contractor and an amount for profit. Administrative overheads and project overheads include but are not limited to the following:

Advertising, amortization, association and convention fees, audit and accounting fees, bad debt, bank charges and interest, building repairs - head office, capital tax, computer costs, donations, freight and express, insurance - liability and property, interest on long term debt, licences and permits - non Equipment related, management bonuses, management fees subcontracts, management salaries, municipal taxes, office and land - rent or lease, performance, labour and Material bonds, pit rehabilitation - commercial, plans, postage, printing and stationary, promotions, radio, Hand Tools or equipment that are tools of the trade, clothing allowance, sundry, supplies - operation, Utilities: telephone, heat, light, and water, and vehicles repairs - light trucks and autos.

Operated Rented Equipment means Rented Equipment rented or leased 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.

Rented Equipment means Equipment that is rented or leased from an individual, firm, or corporation that is not an associate or affiliate of the lessee as defined by the *Securities Act*, R.S.O. 1990, c. S.5, as amended, and is approved by the Contract Administrator.

Standby Time means any period of time that is not considered Working Time and that 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 and remains on the site in order to continue with its assigned task and during which time the unit is in fully operable condition.

The 127 Rate means the rate for a unit of equipment as listed in OPSS 127, Schedule of Rental Rates for Construction Equipment, Including Model and Specification Reference, which 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 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, Standards, and provisions of the Contract.

Working Time means each period of time during which a unit of Equipment of necessity and is actively 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 and remains on the site in order to continue with its assigned tasks and during which time the unit is in a fully operable condition.

GC 8.03.02 Daily Work Records

- .01 Daily Work Records reporting the labour and Equipment employed and the Material used shall be prepared by the Contractor's representative. The Daily Work Records shall be signed each Day by both the Contractor's representative and the Contract Administrator. The Contract Administrator will note disagreements on the Daily Work Record prior to signing and return a copy to the contractor. These records shall be used for the basis of payment.
- .02 Daily Work Records shall report the labour and Equipment employed, both working time and downtime, and the Material used on Owner Standard Form PH-CC-754 Daily Work Record. Daily Work Records shall include a brief description of the work being carried out and location of such work.
- .03 For each Day that a Daily Work Record is required under these provisions, the Contractor shall deliver daily to the Contract Administrator's representative at the working area a Contractor signed copy of the Daily Work Record.
- .04 The Contractor's failure to keep or deliver Daily Work Records or to keep complete Daily Work Records may limit the Contractor's ability to recover its costs.

GC 8.03.03 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.
- .02 Payment for labour, Rented Equipment, and Operated 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 shall be negotiated according to subsection GC 3.14, Clarification and Claims. Consideration shall be given to removing the labour and Equipment from the site until the idled Work can be resumed.

GC 8.03.04 Payment for Labour

- .01 The Owner shall pay the Contractor for labour used on each Time and Material basis at 100% of the Cost of Labour. Payroll Burden shall not be applied to room and board and or travel expenses when calculating the Cost of Labour.
- .02 Payments in respect of Payroll Burden shall be made at the following rates:
- a) Union workers - 40% of the wages and salary portion of the Cost of Labour.
 - b) Non-union workers - 30% of the wages and salary portion of the Cost of Labour.
 - c) Alternatively, the Contractor's external auditor shall complete, sign, and submit a copy of the Contractor's Actual Payroll Burden. The following shall apply when this option is used:
 - i. Actual Payroll Burden shall be calculated using Owner Standard Form PH-CC-819, Actual Payroll Burden, and only those items stated under clause GC 8.03.01, Definitions, shall be included.
 - ii. Owner Standard Form PH-CC-819, Actual Payroll Burden, shall be completed by the Contractor's external auditor and filed with the Contract Management Office, St Catharines.
 - iii. The Actual Payroll Burden shall be filed annually and shall be applied from April 1 of each year to March 31 of the following year. The Actual Payroll Burden can be adjusted once annually upon submission of a revised Owner Standard Form PH-CC-819, Actual Payroll Burden, completed by the Contractor's external auditor.
 - iv. The Owner shall apply union workers or non-union workers Payroll Burden which ever is applicable, to Contractors failing to provide an annual update by April 1 of the current year. Once Owner Standard Form PH-CC-819, Actual Payroll Burden, is received, the Owner shall apply the new rate from the date of receipt of an acceptable Actual Payroll Burden to March 31 of the following year.
 - v. The Contractor's Actual Payroll Burden rate shall apply universally to all labour areas across the province.
 - d) At the Owner's discretion, a review of the Actual Payroll Burden may be conducted, in which case, the Actual Payroll Burden so determined at the time of the review shall be applied to all Work on a Time and Material Basis affected. Upon request, the Contractor shall make available all records in support of the Actual Payroll Burden calculation submitted.

GC 8.03.05 Payment for Material

- .01 The Owner shall pay the Contractor for Material at 100% of the cost of the Material.

GC 8.03.06 Payment for Equipment

GC 8.03.06.01 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 75% of The 127 Rates.
- .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. A Contractor shall obtain approval from

the Contract Administrator prior to the use of the Rented Equipment, if 110% of the invoice price is greater than 75% of The 127 Rates.

- .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.
- .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 8.03.06.02 Standby Time

- .01 The Owner shall pay the Contractor for Standby Time of all Equipment other than Rented Equipment and Operated Rented Equipment at 50% of The 127 Rate.
- .02 The Owner shall pay for Rented Equipment and Operated Rented Equipment at 100% of the invoice price where it is necessary to retain Equipment in the Working Area for extended periods agreed to by the Contract Administrator.

GC 8.03.06.03 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 the Work according to 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.

GC 8.03.06.04 Mark-Up on Work on a Time and Material Basis

- .01 Payment for Mark-Up on Work on a Time and Material Basis shall be made at the following rates:
 - a) Contractor Mark-Up

15% applied to the total payment for labour, Equipment, and Material when the work was completed by the Contractor.
 - b) Subcontractor Mark-Up

15% applied to the total payment for labour, Equipment, and Material when the work was completed by the Subcontractor.
 - c) Contractor Mark-Up on Subcontractors Work on a Time and Material Basis:

10% mark-up allowed on Subcontractor's total labour, Equipment, and Material after Subcontractor Mark-Up is applied. If Work on a Time and Material Basis is assigned or sublet to an associate, as defined by the *Securities Act*, R.S.O. 1990, c. S.5, as amended, no Contractor Mark-Up is permitted.

GC 8.03.06.05 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 the Work. The Contractor shall provide documented proof of labour and Equipment rates when requested by the Contract Administrator.
- .02 A separate Owner Standard Form PH-CC-796, Time and Material Summary for Payment, shall be completed for Contractor and Subcontractor Work on a Time and Material Basis. Each completed form shall include the Change Order number and covering dates of the Work on a Time and Material Basis and shall itemize separately payment for labour, payment for Materials, and payment for 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 certificate, the costs of the Work on a Time and Material Basis incurred during the preceding month all according to the Contract administrative procedures and the Contractor's invoice of the Work on a Time and Material Basis.
- .04 The final Owner Standard Form PH-CC-796, Time and Material Summary for Payment, shall be submitted by the Contractor within 60 Days after the completion of the Work on a Time and Material Basis.

GC 8.04 Release from Warranty

- .01 At the expiry of the last warranty period and after correction of all deficiencies, the Owner shall issue the Contractor a Release from Warranty Certificate.

GC 8.05 Records

- .01 The Contractor shall maintain and keep accurate Records relating to the Work, Changes in the Work, and Claims arising there from in sufficient detail to support the total cost of the Work, Changes in the Work, and Claims. The Contractor shall preserve all such original Records until 12 months after the Release from Warranty Certificate is issued or until all claims have been settled, which ever is longer. The Contractor shall require that Subcontractors preserve all original Records pertaining to the Work, Changes in the Work, and Claims arising there from for a similar period of time.
- .02 If, in the opinion of the Contract Administrator, Daily Work Records are required, the Contractor shall complete such Daily Work Records for the Work or such specific part of the Work requested.

GC 8.06 Taxes and Duties

- .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 bidding, 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 Owner Standard Form, PH-CC-725 Tax Change Statement. Such claims for additional tax costs shall be submitted not later than 30 Days after the date of completion of the Work.
- .03 Where the Contractor benefits from a change in Canadian Federal or Provincial taxes, the Contractor shall submit a statement of such benefits to the Contract Administrator on Owner

Standard Form, PH-CC-725 Tax Change Statement. This statement shall be submitted not later than 30 Days after the date of completion of the Work.

- .04 The Contract Administrator reserves the right to make deductions from regular progress payments to compensate for the estimated benefit from decreased tax costs. Such deductions shall be set-off from Contract payments pending receipt of the statement itemizing the benefits that have resulted from a decrease in tax costs at which time the final payment adjustment shall be determined.
- .05 Changes in Federal or Provincial taxes impacting upon commodities that, 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.

GC 8.07 Liquidated Damages

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

TABLE 7.02-1
Layout Intervals and Measurement Accuracy
for Construction Survey - Layout

Activity	Interval m	Measurement Accuracy mm	Remarks
Layout - Rock - Earth	10 25	-	With the exception of plus sections, layout is normally at the same interval as the cross-sections/grade calculations. This may be varied when extreme changes in horizontal and vertical alignment are encountered.
Maximum for setting structure footing grades	10	-	
Set structure grades	-	1	
Adjustment to slope stake distances to allow for grubbing losses	-	300	
Set grades for earth grading	-	10	
Set grades for granular	-	5	
Layout stake offset for curb and gutter	-	-	2 m but may be varied to suit conditions
Stake layout for curb and gutter	10	-	May be necessary to reduce for very sharp curves
Set curb and gutter grades	-	1	
Staking maximum for layout of a radius, intersections	3	-	
Layout stake offset for concrete pavement	-	-	2 m offset
Set concrete pavement grades	-	1	

TABLE 7.02-2
Layout Intervals and Measurement Accuracy
for Construction Survey - Cross-Sections

Activity	Interval m	Measurement Accuracy mm	Remarks
Backsight and foresight readings	-	1	
Maximum allowable error between adjacent Bench Marks	-	5	
Intermediate road readings - earth cut - rock cut - rock cut with overburden - muskeg excavation - fills with stripping, sub-excavation, or ditching - transition from cut to fill - fills - earth or rock fills - borrow pits	25 10 10 25 25 25 25 25 25 25	10	
Maximum transverse interval for cross-section elevations - earth - rock - borrow	25 10 25	-	
Measure offset distances	-	100	

**TABLE 8.02.04.02-1
Fuel Consumption Rates**

	Item Description	Notes	Diesel Fuel Consumption Rates
1	Clearing including Close Cut Clearing		237 L/ha
2	Grubbing		163 L/ha
3	Earth Excavation and Earth Borrow	1	1.7 L/m ³
4	Rock Excavation	2	0.6 L/m ³
5	Rock Embankment		1.6 L/m ³
6	Rock Face		1.2 L/m ²
7	Select Subgrade Material (SSM)		1.0 L/t
8	Granular A, B ,O, and RSS Backfill		1.9 L/t
9	All Asphalt Pavement, except SuperPave FC2		11.5 L/t
10	SuperPave FC2 Pavement		14.3 L/t
11	Concrete Pavement		4.9 L/m ²
12	Structural Concrete	3	5.5 L/m ³
13	Tall Wall, any non-precast barrier wall, including asymmetric		3.2 L/m
14	Milling by m ² Items	4	0.4 L/m ²
15	Milling by tonne Items	5	3.0 L/t
16	Pulverize		0.2 L/m ²
17	Cold In Place Recycling		0.4 L/m ²
18	Concrete Removal, all complete structural concrete	6	1.0 L/m ³
19	Concrete Removal, concrete base and pavements		0.9 L/m ²
20	Asphalt Removal	7	0.4 L/m ²
21	Piling & Caissons		5.0 L/m
22	Sewers & Drainage	8	8.0 L/m
23	Rock Supply		1.4 L/m ³

Notes:

- Also includes the Tender Item Earth Excavation for Structures when the quantity is greater than 100 m³.
- If the Contract has a Rock Excavation item but not the Rock Embankment item, the diesel fuel consumption rate for Rock Excavation shall be 2.2 L/m³.
- Structural concrete is normally a lump sum item that has no quantity listed in the Contract. The Contract Administrator shall calculate the quantity for this item or get concrete ticket summary sheets for this item. This item does not include deck joint assemblies or modifications, concrete patches, or precast units.

Includes the following items:

- concrete in deck	- high performance concrete in sub structures
- concrete in substructure	- concrete in structure
- concrete in culverts	- concrete in approach slab
- high performance concrete in deck	- high performance concrete in barrier walls
- concrete in footing, structure	- concrete in parapet walls
- concrete in substructure and retaining wall	

Table continued on next page

Table continued from previous page

4. Includes the following items:

- removal of asphalt pavement from concrete surfaces
- removal of asphalt pavement, partial depth
- removal of asphalt pavement from concrete surfaces on structures
- reclaim asphalt pavement, full depth
- remove asphalt pavement and salvage; full depth
- reclaim asphalt pavement, full depth over concrete

5. Includes the following items:

- reclaim asphalt pavement, partial depth
- remove asphalt pavement and salvage, partial depth

6. Includes the following items:

- removal of bridge structures
- concrete removal, full depth
- concrete removal, complete deck

7. Includes the following items:

- removal of asphalt pavement

8. Sewers and drainage is to be applied to sewers that are 300 mm in diameter or larger. Subdrains do not receive compensation. Catch basins with a single stub outlet receive no compensation nor do flexible pipe culverts.



NOTICE TO USERS OF OPSS.PROV 106

GENERAL SPECIFICATION FOR ELECTRICAL WORK

OPSS.PROV 106 has been replaced by OPSS 106
located in

OPS Volume 1
Municipal and Provincial Common
General and Construction Specifications

**USE OF THE SPECIFICATION IS AS SPECIFIED
IN THE CONTRACT DOCUMENTS**



GENERAL SPECIFICATION FOR THE USE OF EXPLOSIVES

TABLE OF CONTENTS

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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 provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

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 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.

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 5 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.

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 5 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 from the area of the blast 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 2 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 and those within 150 m of the location 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 500 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.

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 5 Business Days and not less than 4 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 7 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 1. 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
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 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

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



**GENERAL SPECIFICATION FOR
ENVIRONMENTAL PROTECTION FOR CONSTRUCTION IN AND AROUND
WATERBODIES AND ON WATERBODY BANKS**

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APPENDICES

182-A	Commentary

182.01	SCOPE

This specification covers the environmental protection requirements and mitigation measures that apply to construction involving work in and around waterbodies and on waterbody banks.

182.01.01 Specification Significance and Use

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

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 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.

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

Ontario Provincial Standard Specification, Construction

OPSS 518	Control of Water from Dewatering Operations
OPSS 804	Seed and Cover
OPSS 805	Temporary Erosion and Sediment Control Measures

Ontario Ministry of Transportation Publications

MTO/DFO/OMNR Protocol for Protecting Fish and Fish Habitat on Provincial Transportation Undertakings
MTO Environmental Guide for Fish and Fish Habitat

Canadian and Provincial Statutes

Endangered Species Act, S.O. 2007, c. 6
Fisheries Act, R.S.C., 1985, c. F-14
Fish and Wildlife Conservation Act, S.O. 1997, c. 41 - Ontario Regulation 664/98 - Fish Licensing
Species at Risk Act, S.C. 2002, c. 29

Canadian and Provincial Policy

Fish and Wildlife Conservation Act, S.O. 1997, c. 41 - Part IV of Ontario Regulation 664/98
Fisheries and Oceans Canada Freshwater Intake End-of-Pipe Fish Screen Guideline
Fisheries and Oceans Canada Protocol for the Detection of Fish Species at Risk in Ontario Great Lakes Area

182.03 DEFINITIONS

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

Cofferdam means a temporary enclosure constructed within a waterbody to allow the enclosed area to be pumped out, creating a dry work environment.

Deleterious Substance means as defined by the Fisheries Act.

Entrainment means when a fish is drawn into a water intake and cannot escape.

Endangered Species Act Permit means as defined by the Endangered Species Act.

Fish means as defined by the Fisheries Act.

Fish Habitat means as defined by the Fisheries Act.

Fish Salvage means the physical relocation of fish from the work area.

Fish Screen means a device designed to prevent fish from swimming or being drawn into a water intake pipe.

Fisheries Protocol means MTO/DFO/OMNR Protocol for Protecting Fish and Fish Habitat on Provincial Transportation Undertakings.

High Water Level means the usual or average level to which a body of water rises at its highest point and remains for sufficient time so as to change the characteristics of the land. In flowing waters (rivers, streams) this refers to the active channel/bank-full level, which is often the 1 to 2 year flood flow return level.

Impingement means when an entrapped fish is held in contact with the intake screen and is unable to free itself.

In-Water Work Timing Window means a period of time when construction in and around a waterbody is permitted and is established by Ontario Ministry of Natural Resources and Forestry (MNRF).

Licence to Collect Fish for Scientific Purposes means as defined in Part IV of Ontario Regulation 664/98, under the Fish and Wildlife Conservation Act.

Local Seed Bank means all the seeds existing in the topsoil in a riparian vegetation area containing native species to the project site which propagate quickly and are healthy and free of disease or pests.

Low Water Level means the lowest point on the bank or stream bed of a waterbody where the water level recedes to during low flow events or periods.

Mitigation means a measure to reduce the spatial scale, duration, or intensity of serious harm to fish that cannot be completely avoided. The best available mitigation measures or standards should be implemented by proponents as much as is practically feasible.

Normal Water Level means the average water level that occurs between high water level events or periods and low water level events or periods.

Offsetting means measures that are undertaken to counterbalance unavoidable serious harm to fish resulting from a project, with the goal of maintaining or improving the productivity of the commercial, recreational or Aboriginal fishery.

Qualified Fisheries Assessment Specialist means an individual who meets the requirements of the Fisheries Assessment specialty and is registered on MTO's Consultant Registry.

Qualified Fisheries Contracts Specialist means an individual who meets the requirements of the Fisheries Compliance During Contracts specialty and is registered on MTO's Consultant Registry.

Riparian Vegetation Areas means vegetation areas within 30 m of the top of a waterbody bank.

Sediment means soils or other surface material transported by wind or water as a result of erosion. Sediment is a deleterious substance.

Species at Risk Act Permit means as defined in the Species at Risk Act.

Species at Risk means a provincially or federally aquatic species listed as extirpated, endangered, threatened or a species of special concern.

Temporary Flow Control means a temporary flow control device in conjunction with a temporary water conveyance device that is used to isolate a work area from a waterbody.

Temporary Watercourse Crossing means a short term access across a watercourse by construction vehicles when an existing crossing is not available or practical to use.

Waterbody means any permanent or intermittent, natural or constructed body of water including lakes, ponds, wetlands and watercourses.

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.

182.04 DESIGN AND SUBMISSION REQUIREMENTS

182.04.01 Submission Requirements

182.04.01.01 Fish Salvage Licencing

Unless otherwise specified in the Contract Documents, a Licence to Collect Fish for Scientific Purposes shall be obtained from the Ontario Ministry of Natural Resources and Forestry (MNRF) prior to any in-water works.

Copies of the all permits and licences obtained from regulatory agencies shall be submitted to the Contract Administrator upon receipt.

182.04.01.02 Fisheries Specialists

When a fisheries specialist(s) is required, the name(s) of the Qualified Fisheries Contracts Specialist(s) and, if applicable, Qualified Fisheries Assessment Specialist(s), shall be provided to the Contract Administrator a minimum of 10 business days prior to the commencement of work at each location where specialist oversight is specified.

182.05 MATERIALS

All Materials used to provide environmental protection shall not contain any deleterious substances.

182.06 EQUIPMENT

All Equipment used for the work in waterbodies or on waterbody banks at all times shall be free of excess or leaking fuel, lubricants, coolant and any other deleterious substances that could enter the waterbody.

182.07 CONSTRUCTION

182.07.01 General Requirements

All construction activities shall comply with the timing windows specified in the Contract Documents for in-water work.

In addition to the environmental protection requirements specified elsewhere in the Contract Documents, all Work shall be controlled to provide effective waterbody and fish habitat protection. All in-water construction activities shall not interfere with fish passage. If fish are observed in the work area during construction the work shall cease and the fish salvaged.

Unless specified in the Contract Documents, waterbodies shall not be permanently diverted, relocated, blocked, or filled.

When temporary flow control must be undertaken for the Work, it shall be according to the Contract Documents. When temporary flow control is undertaken using a pump, the intake shall be controlled to prevent entrainment and/or impingement of fish and other aquatic wildlife.

All stockpiled materials, including but not limited to excavated overburden and topsoil, excess materials, construction debris and containers shall be stored and stabilized in a manner that prevents them from entering any waterbody.

All materials such as paint, primers, blasting abrasives, rust solvents, degreasers, grout, or other chemicals shall not enter a waterbody.

All building materials used in a waterbody shall be handled and treated in a manner to prevent the release or leaching of substances into a waterbody that may be deleterious to fish.

All waste materials (e.g., dredging spoils, construction waste and materials, commercial logging waste, uprooted or cut aquatic plants, accumulated debris) shall be contained and stabilized above the high water level of nearby waterbodies to prevent re-entry.

182.07.02 Operation of Equipment in Waterbodies or on Waterbody Banks

Equipment shall arrive on site in clean condition. It shall be operated on dry land in a manner that minimizes disturbance to waterbody banks and riparian vegetation areas.

Unless specified in the Contract Documents, Equipment shall not enter or be operated in waterbodies or on waterbody banks but shall be operated on land above the high water level, on ice, or from a floating barge in a manner that minimizes disturbance to the waterbody banks of the watercourse.

Equipment refueling and maintenance shall take place at locations as far away as practical from a waterbody and in a manner that prevents sediment and other deleterious substances from entering into a waterbody.

182.07.03 Preservation of Riparian Vegetation

Removal of riparian vegetation shall be kept to a minimum to help maintain the stability of waterbody banks. The area over which vegetation in riparian vegetation areas is removed shall affect no more than one third (1/3) of the total woody vegetation in the right-of-way within 30 metres of the ordinary high water level of a waterbody. Vegetative root masses found within the waterbody banks shall remain undisturbed unless specified in the Contract Documents.

Existing trails, roads or cut lines shall be used wherever possible as access routes to avoid disturbance to waterbody banks and riparian vegetation areas.

182.07.04 Erosion and Sediment Control

The installation, monitoring, maintenance, and removal of temporary erosion and sediment control measures shall be according to OPSS 805.

Erosion and sediment control measures shall be in place prior to any soil disturbance and shall remain effective at all times, including seasonal and other shut down periods.

Site isolation measures (i.e. coffer dams, turbidity curtains) shall be installed prior to any in-water work activities taking place and shall remain effective at all times to allow the contractor to work in a manner that prevents sediment from entering into a waterbody.

Measures for managing water being pumped and or diverted from the site shall be in accordance with OPSS 518.

182.07.05 Restoration of Disturbed Areas

All disturbed areas shall be stabilized with effective temporary erosion and sediment control measures that shall be maintained until vegetation is established.

Immediately after disturbance or upon completion of the work in or around waterbodies, waterbody banks, and riparian vegetation areas, the disturbed areas shall be restored to the original contour and gradient and cover treatment applied according to the following:

- a) Seed and mulch according to OPSS 804 or 150 mm of topsoil with salvaged local seed bank shall be applied to areas that are flat or sloped not steeper than 3:1.
- b) Seed and matrix or seed and erosion control blanket according to OPSS 804 shall be applied to exposed and disturbed slope areas steeper than 3:1.
- c) Seed type shall be Lowland Mix according to OPSS 804.

If an area cannot be restored to the original contour and gradient due to instability or other reasons, a stable gradient shall be constructed and cover treatment applied according to the above requirements.

Materials for the restoration of disturbed areas shall not be obtained from below the high water level of any waterbody unless specified in the Contract Documents.

182.07.06 Fish Protection

182.07.06.01 Fish Salvage

Fish stranded by the Work or found in the work area during construction shall be salvaged and relocated according to the Licence to Collect Fish for Scientific Purposes, unless specified in the Contract Documents. If fish cannot be safely relocated, the local MNRF office shall be consulted prior to fish collection commencing to determine a suitable relocation site.

Fish exclusion measures (i.e. block nets) shall be used to prevent fish from re-entering work areas. In the event that the fish exclusion measures fail, additional fish salvage activities shall be performed to relocate the fish from the work areas prior to recommencing construction.

All fish shall be handled as little as possible and in a manner that minimizes stress and prevents death to the fish.

All persons conducting electrofishing shall possess valid Ontario Electrofishing Certification.

182.07.06.02 Reporting Species at Risk

When an aquatic species (i.e. fish and/or mussel) protected under the Federal Species at Risk Act (SARA) or the Ontario Endangered Species Act (ESA) is incidentally captured during fish salvage activities, the individual that incidentally captured the aquatic species at risk shall take a digital photograph. Once the digital photograph has been taken the species shall be released immediately. The digital photograph shall be reported and emailed to the Contract Administrator, the local MNRF District Office, and the Fisheries and Oceans Canada (DFO) Central and Arctic Region Fisheries Protection Program.

All mortalities of species protected under the SARA or ESA associated with the fish salvage activities shall be reported to the Contract Administrator, the MNRF District Office, and the DFO immediately upon being discovered. Mortalities shall be vouchered according to the Fisheries and Oceans Canada Protocol for the Detection of Fish Species at Risk in Ontario Great Lakes Area and/or Fisheries and Oceans Canada Protocol for the Detection and Relocation of Freshwater Mussel Species at Risk in Ontario Great Lakes Area

182.07.06.03 Fish Screens

Any water intakes or outlet pipes in fish bearing waters shall have screens to prevent entrainment or impingement of fish and follow the measures as outlined in Fisheries and Oceans Freshwater Intake End-of-Pipe Fish Screen Guideline.

182.07.06.04 Fisheries Specialist Services

When oversight by a Fisheries Specialist is required for a location as specified in the Contract Documents, a Qualified Fisheries Contracts Specialist shall be retained to provide the following services:

- a) Work with construction personnel to protect fish and fish habitat;
- b) Work with construction personnel in the development of waterbody and fisheries protection strategies and plans, when specified in the Contract Documents;
- c) Liaise with the Owner, the Contract Administrator, and, as necessary, Regulatory Agency representatives regarding Fisheries Act Authorization requirements;
- d) Be on-site to inspect and confirm the proper installation, functioning and decommissioning (as appropriate) of all temporary and permanent mitigation measures as specified in the Contract

Documents, including providing field fit advice and necessary corrective actions for issues of non-compliance;

- e) Complete and submit all monitoring documentation as specified in Table 1.
- f) Capture and relocate fish as necessary under a Licence to Collect Fish for Scientific Purposes;
- g) Inspect erosion and sediment control measures within 24 hours after a rain event;
- h) Review Change Proposals for compliance with the Fisheries Act. If the Fisheries Protocol requires the completion of a fisheries assessment, it shall be conducted by a Qualified Fisheries Assessment Specialist.

182.07.07 Contingency Measures

When an environmental protection measure is found to be ineffective, corrective actions shall be taken immediately including repair or replacement of the measure to ensure waterbody and fish habitat protection.

182.07.08 Management of Excess Materials

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 that requires fisheries protection requirements and mitigation measures shall include 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.

Table 1
Qualified Fisheries Contracts Specialist - Monitoring Documentation

Documentation Name (Note 1)	Warrant for Completion	Distribution
MTO Construction Inspection Checklist	Every day that a Fisheries Contracts Specialist is on site	Within 1 Business Day of inspection, submit one (1) electronic copy of the inspection checklist to Contract Administrator.
MTO Non - Compliance Summary	Friday of each week when the Contractor is not in compliance with the Fisheries Act Authorization	By the following Monday, submit one (1) electronic copy of the non-compliance summary to Contract Administrator.
MTO Construction Monitoring Report	Annually by December 31st on multi-year construction projects and prior to the completion of construction	By November 1 of the monitoring year, submit one (1) electronic copy of the draft report to Contract Administrator. By December 15 of the monitoring year, submit one (1) electronic copy and three (3) hard copies of the final report incorporating MTO comments on the draft to Contract Administrator.
Notes: 1. The above noted documents and requirements for completion shall be obtained from the MTO Environmental Guide for Fish and Fish Habitat.		

Appendix 182-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

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



**GENERAL SPECIFICATION FOR
TEMPORARY FLOW CONTROL FOR
CONSTRUCTION IN WATERBODIES**

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185.07	CONSTRUCTION
185.08	QUALITY ASSURANCE - Not Used
185.09	MEASUREMENT FOR PAYMENT - Not Used
185.10	BASIS OF PAYMENT

APPENDICES

185-A	Commentary

185.01 SCOPE

This specification covers the requirements for the design, installation, operation, maintenance and removal of temporary flow control in waterbodies during construction.

185.01.01 Specification Significance and Use

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

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

185.01.02 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.

185.02 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.

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

Ontario Provincial Standard Specifications, Construction

OPSS 518	Control of Water from Dewatering Operations
OPSS 801	Tree Protection
OPSS 804	Seed and Cover
OPSS 805	Temporary Erosion and Sediment Control Measures

Canadian and Provincial Statutes

Ontario Water Resources Act, R.S.O.1990, c. 0.40
Ontario Water Resources Act, R.S.O.1990, c. 0.40 - Ontario Regulation 387/04 - Water Taking

185.03 DEFINITIONS

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

Deleterious Substance means as defined in Fisheries Act.

Low Flow Event Return Period means a flow event that has a probability of occurrence equal to or less than once every 2 years.

Original Waterbody Channel means the channel in which a waterbody was flowing prior to the commencement of the work.

Plug means an impervious, natural, or constructed drainage work that blocks water.

Temporary Flow Control means a temporary flow control device in conjunction with a temporary water conveyance device that is used to isolate a Working Area from a waterbody.

Temporary 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 and can include a plug.

Temporary Waterbody Channel means the channel in which a waterbody is flowing at the completion of any temporary waterbody relocation sequence.

Temporary Water Conveyance Device means a device that is used to move water downstream, around or through a Working Area in a waterbody from a temporary flow control device and can include a temporary waterbody channel, a fill and culvert, or a pumping and piping system.

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.

185.04 DESIGN AND SUBMISSION REQUIREMENTS

185.04.01 Design Requirements

Temporary flow control design shall be provided for Work to be undertaken in a waterbody, unless otherwise specified in the Contract Documents.

As a minimum, the temporary flow control shall be designed for the low flow event return period of the waterbody.

The elevation of the highest point of any temporary flow control device shall be a minimum of 0.30 m higher than the surface water elevations for the low flow event return period of the waterbody.

185.04.02 Submission Requirements

185.04.02.01 Working Drawings

Three sets of Working Drawings shall be submitted for information purposes only to the Contract Administrator for the work at each location, at least 2 Days prior to the commencement of the temporary flow control 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.

The following information shall be shown on the Working Drawings:

- a) Plans, Elevations, and Details.
 - i. Location and extent of the temporary flow control.
 - ii. Location and elevation of all elements that form the temporary flow control.
- b) The design flow return period on which the design is based.
- c) The number, type, and capacity of any pumps used in the temporary flow control.

- d) Written procedures that fully describe the sequence and timing of the work, the associated waterbody and fish habitat protection measures, and the related contingency measures associated with each stage of the temporary flow control.

185.07 CONSTRUCTION

185.07.01 General Requirements

Continuous temporary flow control shall be provided to keep the Working Area stable and well drained for the duration of construction in a waterbody.

185.07.02 Operational Constraints

Work shall be undertaken according to the timing constraints specified elsewhere in the Contract Documents.

185.07.03 Permit to Take Water

For any Work that includes temporary flow control requiring the taking of water, a permit to take water, under the appropriate category specified in Ontario Regulation 387/04 made under the Ontario Water Resources Act shall be obtained from the Ontario Ministry of the Environment, unless specified elsewhere in the Contract Documents, prior to the installation of the temporary flow control.

185.07.04 Protection of Trees

Protection of trees not designated for removal shall be according to OPSS 801.

185.07.05 Temporary Erosion and Sediment Control Measures

The installation, maintenance, and removal of temporary erosion and sediment control measures shall be according to OPSS 805.

185.07.06 Sediment Traps

Sediment traps shall be designed, constructed, and maintained according to OPSS 805.

185.07.07 Protection in Waterbodies and on Waterbody Banks

Protection in waterbodies and on waterbody banks shall be according to the Contract Documents.

185.07.08 Control of Water from Dewatering Operations

The control of water from dewatering operations shall be according to OPSS 518.

185.07.09 Seed and Cover

Seed and cover shall be according to OPSS 804.

185.07.10 Installation

185.07.10.01 Installation of a Temporary Flow Control Outside of a Waterbody

As a minimum, temporary flow control outside of a waterbody shall be deployed according to the following sequential steps:

- a) The temporary flow control shall be constructed or installed according to the design submitted to the Contract Administrator. Upstream and downstream plugs separating the original waterbody channel and the temporary water conveyance device shall remain in place.
- b) The downstream plug shall be opened to allow water into the temporary water conveyance device and water pressure shall be allowed to equalize between the original waterbody channel and the temporary water conveyance device.
- c) The upstream plug shall be opened to allow water to flow through both the original waterbody channel and the temporary water conveyance device.
- d) A plug shall be installed in the original waterbody channel, at the inflow confluence of the original waterbody channel and the temporary water conveyance device, to fully divert the water to flow through the temporary water conveyance device.
- e) A plug shall be installed in the original waterbody channel, at the outflow confluence of the temporary water conveyance device and the original waterbody channel, to prevent backflow into the original waterbody channel.
- f) The original waterbody channel isolated by the temporary waterbody channel shall be dewatered and any stranded fish shall be rescued as required.
- g) If cover material is specified in the design, it shall be applied immediately after exposure of soils.

185.07.10.02 Installation of a Temporary Flow Control Within a Waterbody

At a minimum, temporary flow control within a waterbody shall be deployed according to the following sequential steps:

- a) The temporary flow control shall be constructed or installed according to the design submitted to the Contract Administrator. An upstream temporary flow control device shall be installed to divert water flow into the temporary flow control according to the design.
- b) A plug shall be installed in the original waterbody channel, at the inflow confluence of the original waterbody channel and the temporary water conveyance device, to fully divert the water to flow through the temporary water conveyance device.
- c) A plug shall be installed in the original waterbody channel, at the outflow confluence of the temporary water conveyance device and the original waterbody channel, to prevent backflow into the original waterbody channel.
- d) The original waterbody channel, isolated by the temporary waterbody channel, shall be dewatered and any stranded fish shall be rescued as required.
- e) If cover material is specified in the design, it shall be applied immediately after exposure of soils.

185.07.11 Removal

185.07.11.01 Removal of a Temporary Flow Control Outside of a Waterbody

As a minimum, temporary flow control outside of a waterbody shall be removed according to the following sequential steps:

- a) All Work in the Working Area shall be completed and the temporary flow control, isolated by the temporary waterbody channel, shall be stabilized according to the Contractor's design prior to returning the flow of water to the original waterbody channel.

- b) 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 control.
- c) 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 control.
- d) A plug shall be installed in the temporary flow control, at the inflow confluence of the original waterbody channel and the temporary flow control, to fully divert the water to flow through the original waterbody channel.
- e) A plug shall be installed in the temporary flow control, at the outflow confluence of the temporary flow control and the original waterbody channel, to prevent backflow into the temporary flow control.
- f) The isolated temporary flow control shall be dewatered.

185.07.11.02 Removal of a Temporary Flow Control Within a Waterbody

As a minimum, temporary flow control within a waterbody shall be removed according to the following sequential steps:

- a) All Work in the Working Area shall be completed and the original waterbody channel, isolated by the temporary flow control, shall be stabilized in accordance with the Contractor's design prior to returning the flow of water to the original waterbody channel.
- b) The downstream plug shall be removed.
- c) The upstream plug shall be removed.
- d) The temporary flow control shall be removed.

185.07.12 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

185.10 BASIS OF PAYMENT

Payment at the Contract price for the appropriate tender items that require temporary flow control shall include 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 185-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

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



**CONSTRUCTION SPECIFICATION FOR ROCK REMOVAL
BY MANUAL SCALING, MACHINE SCALING, TRIM BLASTING,
OR CONTROLLED BLASTING**

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202-A	Commentary

202.01 SCOPE

This specification covers the requirements for removing rock by manual scaling, machine scaling, trim blasting, or controlled blasting.

202.01.01 Specification Significance and Use

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

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 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.

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

Ontario Provincial Standard Specifications, Construction

OPSS 206 Grading

202.03 DEFINITIONS

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

Controlled Blasting means cushion blasting, line drilling, and pre-shearing as defined in OPSS 206.

Grubbing means as defined in OPSS 206.

Mucking means as defined in OPSS 206.

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.

Rock Face means as defined in OPSS 206.

Scaling means as defined in OPSS 206.

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.

Wall Control Blasting means as defined in OPSS 206.

202.04 DESIGN AND SUBMISSION REQUIREMENTS

202.04.02 Submission Requirements

A minimum of 5 Business Days prior to beginning the Work, the name and contact number of the on-site person that is responsible for the Work being carried out (i.e., foreman) and a written statement showing that the person has had at least 5 years of related work experience, including dates, and has taken all appropriate safety training shall be submitted to the Contract Administrator.

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 specified in the Contract Documents.

202.06.03 Backhoe Excavator

Backhoe 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

A backhoe excavator shall be equipped with a minimum 5,200 Joule hydraulic impact hammer.

202.07 CONSTRUCTION

202.07.01 General

The work of 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 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 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 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 foreman 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

The work of manual scaling shall consist of the complete removal of all loose and partially-detached rock at the locations and heights specified in the Contract Documents by the manual scaling work unit and in addition to all of the other items specified in the Contract Documents, shall also include the following:

- a) Rock cut sounding.
- b) Scaling of the rock cut with hand tools and hand-held machine tools.

Manual scaling may include blasting with small quantities of explosives, but only when specified as an option 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 and have taken the appropriate safety training.
- b) All tools and materials required for the performance of the work.

202.07.02.03 Machine Scaling

The work of machine scaling shall consist of the complete removal of all loose rock and partially-detached rock at the locations and heights specified in the Contract Documents by the machine scaling work unit and in addition to all of the other items specified in the Contract Documents, shall also include the following:

- a) Grubbing.
- b) Rock cut sounding.
- c) Scaling of the rock cut.

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) Backhoe and hoe-ram excavator operators with experience in machine scaling work.
- c) All tools and materials required for the performance of the work.

202.07.03 Trim Blasting or Controlled Blasting

202.07.03.01 General

The work of trim blasting or controlled blasting shall consist of drilling and blasting to remove the rock specified for removal 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

In addition to all of the other items specified in the Contract Documents, the work of trim blasting shall also include locating and drilling 50 mm diameter vertical holes along the perimeter of the specified trim at a maximum spacing of 750 mm or at a spacing approved by the Contract Administrator.

202.07.03.03 Controlled Blasting

In addition to all of the other items specified in the Contract Documents, the work of controlled blasting shall also include the appropriate wall control blasting techniques, as specified for rock face in OPSS 206.

202.07.04 Management of Excess Material

Management of excess material shall be as specified in the Contract Documents.

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 in effective operation.

Effective operation shall not include the time taken for the management and disposal of the materials generated by the scaling operation.

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 working on the site in effective operation.

Effective operation shall not include the time taken for the management and disposal of all materials generated by the scaling operation or for the construction of any associated ramps.

202.09.01.03 Rock Excavation, Trim Blasting

Measurement of rock excavation by trim blasting shall be by vertical length in metres of drilling required.

202.09.01.04 Rock Excavation, Controlled Blasting

Measurement of rock excavation by controlled blasting shall be by volume in cubic metres of rock measured in-place.

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
Rock Excavation, Controlled 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.

Appendix 202-A, November 2013
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 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 provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

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 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.

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	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	Standard Specification for Concrete Aggregates
C 42	Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
C 150	Standard Specification for Portland Cement

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 2 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 to the Contract Administrator a minimum of 2 weeks for information purposes 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 an 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 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.

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% SiO₂ and having a proven record of performance when used in shotcrete.
- c) Aggregate: Gradation No.2 in ACI 506.2-77 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 7 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 m³/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.

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 3 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 2 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 5 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 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

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR GRADING

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206.10	BASIS OF PAYMENT

APPENDICES

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 provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

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 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.

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

Ontario Provincial Standard Specifications, Construction

OPSS 209	Embankments Over Swamps and Compressible Soils
OPSS 212	Earth Borrow
OPSS 501	Compacting
OPSS 802	Topsoil
OPSS 804	Seed and Cover

Ontario Provincial Standard Specifications, Materials

OPSS 1010	Aggregates - Base, Subbase, Select Subgrade and Backfill Material

Ontario Ministry of Transportation Publications

MTO Form:	
PH-CC-820	Certification of Grade Elevation - Crossfall

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 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. For rock excavation quantities identified as shatter, the bulking factor shall be 0.35.

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 the removal of all stumps, roots, embedded logs, debris, and secondary growth.

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 the processed hot mix asphalt material that is recovered by partial or full depth removal.

Reclaimed Concrete Material (RCM) means removed or processed old Portland cement concrete.

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 m³ 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. 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)

For each construction stage, the following information shall be submitted to the Contract Administrator a minimum of 5 Business Days prior to undertaking the work of 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 as specified 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 the types 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 for the sources where rock materials are obtained for the rock supply item.
- 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, for each construction stage, on a monthly basis, an updated RMMP shall be submitted to the Contract Administrator 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.

The work of rock excavation or rock embankment shall not commence until the RMMP in accordance with the above requirements is submitted.

206.04.01.02 Trial Section for Modified Layer Compaction Method

If the Contractor wishes to request 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 required in the General clause of the Rock Embankments clause shall have a minimum net flywheel power of 200 kW.

206.06.02 Rollers for Shale Embankment Construction

Sheepsfoot, packall, padfoot, or tamping foot rollers 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.

206.07 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 when such material is respectively 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 meeting the requirements of topsoil according to OPSS 802 that is required for re-use shall be stockpiled 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 properly-compacted granular material according to OPSS 1010.

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.

Excavation below grade 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 in roadway cuts shall be shattered to a uniform minimum depth of 300 mm below the theoretical rock subgrade for the full width of the cut, including the ditch.

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 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 up to the rock surplus quantity.

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 Rock Supply

The work shall include any required clearing, grubbing, and stripping of the source; construction and maintenance of access roads; excavating and hauling of rock materials, regardless of whether the hauling is to the Contract limits or for rock surplus; and source rehabilitation.

The rock surplus quantity, if any, is an entitlement of the Contractor. Excavated rock may be removed for the Contractor's purposes or disposed of as the Contractor deems appropriate up to the rock surplus quantity as the staging of the work allows. All materials removed from rock excavation and not placed in rock embankment shall be deemed to be removed as part of the Contractor's rock surplus quantity.

All materials removed as part of the rock surplus quantity shall be accurately measured as specified in the Measurement of Rock Surplus clause and recorded by the Contractor at no additional cost to the Owner. Whenever such measurements are to be taken, the Contractor shall inform the Contract Administrator at least 1 Business Day in advance of such measurements.

All weighing of materials shall be as specified in the Contract Documents.

Within 7 Business Days of the Contractor taking a set of measurements, the Contractor shall:

- a) Provide the Contract Administrator with a copy of those measurements and the calculations based on those measurements.
- b) Advise the Contract Administrator, in writing, that the locations where the measurements were taken are ready for verification.

In the event that the Contract Administrator chooses to verify those measurements, such verification shall be undertaken within 3 Business Days of the Contract Administrator being advised that the locations are ready for verification and for those 3 Days, the Contractor shall not:

- a) Place rock on or remove rock materials, as the case may be, from the measured locations; or
- b) Impede the Contract Administrator in any way during the verification of those measurements.

206.07.04.01 Measurement of Rock Surplus

Rock removed as part of the rock surplus quantity shall be measured by the Contractor and verified by the Contract Administrator as specified in the Rock Supply subsection using one or more of the following 4 methods given below:

- a) Weighed Aggregate Production Quantity

All locations to be used for stockpiling processed aggregates shall be identified in writing to the Contract Administrator no less than 3 Business Days prior to production.

At each stockpile location, the Contractor shall complete an accurate survey of the initial ground elevations subject to verification by the Contract Administrator prior to any materials, including materials used for a granular pad, are placed at that location.

All aggregate materials removed from each stockpile within the Contract limits shall be weighed by the Contractor for reconciliation with the rock surplus quantity by converting the mass to a bulked broken rock volume using a factor of 0.519 m³/tonne.

Once all of the aggregates have been removed, each stockpile shall be re-surveyed by the Contractor, the measurements verified by the Contract Administrator, and the volume of material remaining determined by the Contractor.

Quantities of rock used for aggregate production and quantities of materials remaining in aggregate stockpiles shall be deducted from the rock surplus quantity.

Any materials that are added to an aggregate production stockpile within the Contract limits that do not come from rock that was excavated on the Contract shall be weighed by the Contractor and subtracted from the weighed aggregate quantity provided. If such materials are not weighed or the Contract Administrator was not given sufficient notice or opportunity by the Contractor to verify the weight of those materials, then no deduction shall be made for those materials.

b) Stockpile Volume

Excavated rock forming part of the rock surplus may be measured in stockpiles constructed by the Contractor. The Contractor shall inform the Contract Administrator, in writing, of the location where each stockpile is to be established a minimum of 3 Business Days prior to commencing any work at that stockpile location. Disposal sites shall be treated as stockpiles.

At each stockpile location, the Contractor shall complete an accurate survey of the initial ground elevations and allow the Contract Administrator to verify those measurements prior to any rock materials are placed at that location.

Once the stockpile has been completed, the stockpile shall then be resurveyed by the Contractor, the measurements verified by the Contract Administrator, and the final volume determined by the Contractor. The Contractor shall not remove any rock material from any such stockpile prior to completion of its final survey and verification by the Contract Administrator.

With the exception of excavated rock placed in rock embankment, the quantity of all other excavated rock placed within the Contract limits (e.g., for widening of pre-existing embankments, construction of access roads, crane bases, etc.) shall be measured in the same manner as the stockpiles described above. Such quantities shall be deducted from the rock surplus quantity.

At the request of the Contract Administrator, the Contractor may be required to conduct backhoe or other subsurface investigations in the Contract Administrator's presence to determine if compressible soils are present at the Contractor's proposed stockpile locations. Backfilling of such investigated areas shall be carried out using properly-compacted material acceptable to the Contract Administrator.

If the Contractor Administrator deems that compressible soils are present, the Contractor shall then re-locate the proposed stockpile or the Contractor shall install monitoring devices at the affected location. Each monitoring device shall consist of a circular 1.0 m diameter 6 mm thick steel plate with a 3.0 m length of 50 mm diameter steel pipe securely welded vertically to the centre of the plate. Whenever the level of rock placement surrounding the monitoring device is vertically within 300 mm of the top of a monitoring device, successive 3.0 m lengths of 50 mm diameter steel pipe shall be welded to the top of that device. The length of each new section shall be added to the original elevation. The Contractor shall be paid to supply and place each monitoring device as specified in the Contract Documents. Any monitoring devices damaged during placement of materials shall be replaced at no additional cost to the Owner.

The Contractor shall survey the top of each monitoring device prior to rock material placement. The Contractor shall resurvey the top of each monitoring device when the placement of rock materials is complete. Both sets of measurements shall be verified by the Contract Administrator. If the difference in elevation between the two surveys is greater than 300 mm, the initial ground elevations for this location shall then be lowered universally by the difference in monitoring device elevation. When more than one monitoring device is placed at a given location, the differences in elevations shall be averaged together.

The Contractor shall ensure that the Contract Administrator has free and unencumbered access to any location where excavated rock is being placed.

c) Weighed Broken Rock

Excavated rock forming part of the rock surplus quantity shall be weighed by the Contractor prior to exiting the Contract limits. The Contract Administrator shall be informed, in writing, at least 2 Business Days in advance that such rock materials are to be weighed as rock surplus, the specific locations where the broken rock material is to be obtained, and the locations where it is to be placed.

Excavated rock weighed as part of the rock surplus shall be converted to a bulked broken rock volume using a factor of 0.519 m³/tonne.

d) In-situ Measure of Distinct Rock Cut

Excavated rock from distinct rock cut locations may be removed as part of the rock surplus specified in the Contractor's RMMP. A distinct rock cut location shall be one that begins with and ends at points of zero rock excavation. The excavated rock shall be used in its entirety as rock surplus material from distinct rock cuts and shall not be split between Contract rock embankment requirements and the rock surplus quantity. This quantity shall be the quantity of the distinct rock cut in cubic meters, multiplied by the bulking factor.

206.07.05 Embankments

Only materials that are specified in the Contract Documents for use in embankments shall be used, unless approved by the Owner, 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 places any topsoil or any other material on the embankment slopes.

206.07.05.01 Earth Embankments

206.07.05.01.01 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 the succeeding layer is placed. 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 m³ 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 the road embankment is built 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.

206.07.05.01.02 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 is 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.

206.07.05.01.03 Modified Layer Compaction Method

The modified layer compaction method may be used if the Contract Administrator deems that it is practical to construct an earth embankment or a portion of an earth embankment in thicker lifts than that specified in the Layer Compaction Method clause.

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 is 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 m² 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.

When it has been successfully demonstrated to the Contract Administrator that compaction can be achieved throughout the entire lift based on the acceptance requirements for a control strip specified in OPSS 501, the procedure that the Contractor used shall then be permitted for the remainder of the work to which it is applicable. Any excavation, backfilling, and re-compaction necessary for establishing the compaction results within the trial section shall be carried out by the Contractor.

If at any time, test results show that the permitted procedure is no longer producing the required degree of compaction, a new trial section shall then be constructed. In this case, the Contractor shall propose changes in the procedure to satisfy the requirements of this specification. Such changes shall be proposed in writing to the Contract Administrator prior to commencing work on the new trial area. Otherwise, the Contractor shall revert back to the layer compaction method as specified in the Layer Compaction Method clause.

206.07.05.02 Rock Embankments

206.07.05.02.01 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 supply 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 thickness prior to compaction. Material in each layer shall be fully compacted prior to 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. The minimum number of complete passes shall be 6 and the maximum number of passes shall be 8. 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. 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 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.
- c) At the direction of the Owner.

206.07.05.02.02 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.

206.07.06 Rock Backfill to Structure

When rock backfill to structures is specified, the rock backfill shall only be comprised of rock fragments no larger than 250 mm in their greatest dimension 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.

206.07.07 Quality Control

206.07.07.01 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 survey crew 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.

206.07.07.01.01 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 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 template is not available, then the Contractor shall complete, sign, and submit MTO form PH-CC-820 to the Contract Administrator.

206.07.07.02 Compaction Quality Control

The Contractor shall use Method B according to OPSS 501 for quality control of compaction.

206.07.08 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 determined 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 be charged for each station where the finished grade is outside of the specification limits, at the rate specified in the Finished Grade Checks Outside Specification Limits subsection.
- c) 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

When the Contract has a rock supply item, the quantity of excavated rock placed beyond the rock grading tolerance at the top of subgrade and beyond the angle of repose for rock fills shall be deducted from the rock surplus quantity 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 Supply

The quantity of rock supply shall be determined in cubic metres either at the end of a distinct stage or at the end of the Contract.

The quantity shall be determined as one of the following:

- a) The rock surplus quantity less the quantities of rock materials removed as part of the rock surplus and measured as specified in the Measurement of Rock Surplus clause.
- b) The quantity of rock materials determined by the Contract Administrator required to complete the embankments.
- c) The total of both a) and b).

At the discretion of the Contract Administrator, earlier access to the rock supply item may be granted; however, the quantities shall be reconciled at the end of the stage or Contract.

The rock supply quantity shall be measured in-situ by the Contractor in neat lines at the source. The in-situ volume shall be the rock supply quantity divided by the bulking factor.

For rock materials supplied under the rock supply item for the completion of rock embankments, any rock materials remaining at the rock supply source after rock embankment construction has been completed or otherwise used on the Contract as specified in the Management of Excavated Materials clause, shall be paid for as specified in the Rock Supply subsection under the Basis of Payment section.

The Contract Administrator shall be informed in writing 2 Business Days prior to commencing drilling operations at the rock supply source or 2 Business Days prior to removing rock from the rock pile or both. The Contract Administrator reserves the right to verify any measurements at any source. The Contractor shall give the Contract Administrator complete access to all such sources.

206.09.01.06 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 Supply - 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, and all costs for fees and royalties.

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.

The unit price tendered for this item is excluded from the provisions specified in the Contract Documents for renegotiation of unit prices.

For rock materials supplied under the rock supply item for completion of rock embankments as specified in the Contract Documents, any rock materials remaining at the rock supply source after completion of all rock excavation and rock embankment construction shall be paid at 50% of the tender unit rate for rock supply.

As specified in part b) of the Measurement of Rock Surplus clause, the Contractor shall be paid \$400.00 for each monitoring device used to monitor compressible soils, regardless of the number of additional pipe sections that are required.

206.10.06 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.

206.10.07 Backfill for Overexcavation

Payment shall not be made for backfill of any overexcavation in excess of the specified tolerances.

206.10.08 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.

206.10.09 Finished Grade Checks Outside Specification Limits

As specified in the Grade Checks subsection of the Quality Assurance section, for each station where the QA grade check of the finished grade is outside of specification limits, the Contractor shall be charged \$250.00.

Appendix 206-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

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



**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 provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

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 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.

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	Earth 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 earth 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 rock as defined in OPSS 206.

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

Earth 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 Geotextiles

Geotextiles 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 m³ bucket or a 40,000 kg crawler mounted dragline with a 1.15 m³ bucket. The bucket 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.

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 in one operation prior to backfilling.

Excavated material shall be placed clear of the sides of the embankment limits and any drainage facilities. The operations of excavating and backfilling shall be carried out simultaneously.

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. Close cut clearing shall be carried out in such a manner as not to damage the structural integrity of the root mat.

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.

Should the geotextile be damaged, it shall be repaired by placing a piece of geotextile large enough to cover the damaged section meeting the above requirements for overlapping.

If the geotextile is damaged due to the Contractor's operation during embankment construction, the embankment material shall be removed from the geotextile.

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 original ground 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 actually engaged in the work.

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 their 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.

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.

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 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 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

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR EARTH BORROW

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212-A	Commentary

212.01 SCOPE

This specification covers the requirements for earth borrow.

212.01.01 Specification Significance and Use

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

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 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.

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 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.

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.

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 borrow material being used in the Work, the Contractor shall provide a list of intended borrow sources and the tonnage that is expected to be used from each source to the Contract Administrator.

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 that the Contractor intends to use as borrow and a detailed plan describing where the Contractor intends to use it.

212.05 MATERIALS

212.05.01 Earth Borrow

Earth borrow shall consist of earth 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.

212.07 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; 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 3 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 2 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 2 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, as specified herein and elsewhere in the Contract Documents.

All 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

Measurement of earth borrow shall be by volume in compacted cubic metres, excluding the volume of any boulders that cannot be accommodated in the Work.

Earth borrow 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.

However, for borrow quantities that are less than 1,000 m³, 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

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 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 2013
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 WICK DRAIN INSTALLATION

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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 provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

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 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.

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)

CAN/CGSB 148.1 No.10-94	Methods of Testing Geosynthetics - Geotextiles - Filtration Opening Size

ASTM International

D 638-10	Standard Test Method for Tensile Properties of Plastics
D 3776/D 3776M-09ae2	Standard Test Methods for Mass per Unit Area (Weight) of Fabric
D 4491-99a(2009)	Standard Test Methods for Water Permeability of Geotextiles by Permittivity
D 4533-11	Standard Test Method for Trapezoid Tearing Strength of Geotextiles
D 4632-08	Standard Test Method for Grab Breaking Load and Elongation of Geotextiles
D 4716-08	Standard Test Method for Determining the (In-plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head
D 4833-07	Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products
D 5199-12	Standard Test Method for Measuring the Nominal Thickness of Geosynthetics

220.03 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 accordance with the requirements of the Contract Documents.

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.

Quality Verification Engineer (QVE) means an Engineer retained by the Contractor qualified to provide the services specified in the Contract Documents.

Recognized Specialist Subcontractor means a subcontractor retained by the Contractor that has proven satisfactory experience in work of this type and magnitude and has completed a minimum of five wick drain installation projects in the last five years.

220.04 DESIGN AND SUBMISSION REQUIREMENTS**220.04.01 Submission Requirements****220.04.01.01 Qualifications**

Prior to the commencement of the Work, the qualifications of the recognized specialist subcontractor shall be submitted to the Contract Administrator.

At least one month prior to commencing the installation of wick drains, the qualifications of the QVE undertaking the certification of the work shall be submitted to the Contract Administrator.

220.04.01.02 Materials

At least 3 weeks prior to the installation of wick drains, the Contractor shall submit to the Contract Administrator the following:

- 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.

The Contractor shall have test results available for the aggregates to be used in the work. At the request of the Contract Administrator, the Contractor shall make available or submit quality control test results. 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 Contractor shall submit to the Contract Administrator the details of the sequence and method of installation outlining the following:

- 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) Alternative methods for overcoming obstructions.
- f) Methods for splicing wick drains.

220.04.01.04 Certificates of Conformance

The following certificates of conformance shall be signed and sealed by the QVE and shall be submitted to the Contract Administrator:

- a) At least 3 weeks prior to the installation of wick drains, a certificate of conformance stating that the equipment, materials, and procedures are capable of achieving successful wick drain installation according to the requirements of the Contract Documents.
- b) Upon completion of the wick drain installation and prior to the placement of any overlying material, a final certificate of conformance stating that the work has been carried out according to the submitted installation procedures and the requirements of the Contract Documents.

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

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.

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 by the Contractor.

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, the Contractor shall demonstrate that the proposed materials, equipment, and installation method produce a satisfactory wick drain installation in accordance with these specifications. The Contractor shall install a minimum of 10 trial wick drains at permanent installation locations designated by the Contractor 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 QVE shall monitor the wick drain installation on a full-time basis. If at any time the QVE 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 7,700 mm².

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 by the Contractor. 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

Wick drains shall be installed vertically, within a tolerance of not more than 10 mm per 500 mm. The Contractor shall maintain a suitable method of verifying the vertical alignment of the mandrel and of determining the depth of the wick drain 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 Contractor shall complete the wick drain from the elevation of the obstruction to the working surface and notify the Contract Administrator. At the direction of the Contract Administrator, the Contractor shall attempt to install a new wick drain within a 500 mm radius of the obstructed wick drain. A maximum of two attempts shall be made as directed by the Contract Administrator.

220.07.06 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

220.08 QUALITY ASSURANCE

220.08.01 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.

Geotechnical instrumentation damaged as a result of the Contractor's activities shall be replaced at no additional cost to the Owner.

Payment shall not be made for rejected wick drains or delays or expenses incurred by the Contractor as a result of improper or unacceptable material or installation.

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 D 5199	mm	≥ 2
		Mass	ASTM D 3776	g/m	≥ 40
	Mechanical	Tensile Strength	ASTM D 638	N	≥ 800
Geotextile	Physical	Material	--	--	Polypropylene, Non-Woven
		Mass	ASTM D 5261	g/m ²	≥ 110
	Mechanical	Grab Tensile Strength	ASTM D 4632	N	≥ 600
		Puncture Strength	ASTM D 4833	N	≥ 200
		Trapezoidal Tear	ASTM D 4533	N	≥ 250
		Filtration Opening Size (FOS)	CAN/CGSB 148.1, Method No. 10	µm	≥ 40
		Permittivity	ASTM D 4491	s ⁻¹	≥ 0.5
Composite Wick Drain	Physical	Width	--	mm	≥ 100
		Thickness	ASTM D 5199	mm	≥ 3
	Mechanical	Discharge Capacity @ 10 kPa	ASTM D 4716	m ³ /s	$\geq 1.2 \times 10^{-4}$
		Discharge Capacity @ 240 kPa	ASTM D 4716	m ³ /s	$\geq 1.0 \times 10^{-4}$

Appendix 220-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

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR TACK COATING AND JOINT PAINTING

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APPENDICES

308-A	Commentary

308.01 SCOPE

This specification covers the requirements for the placement and acceptance of tack coating, and joint painting.

308.01.01 Specification Significance and Use

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

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

308.01.02 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.

308.02 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.

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

Ontario Provincial Standard Specifications, Construction

OPSS 313 Hot Mix Asphalt - End Result

Ontario Provincial Standard Specifications, Material

OPSS 1103 Emulsified Asphalt

Ontario Ministry of Transportation Publications

MTO Laboratory Testing Manual:

LS-200 Penetration of Bituminous Materials

LS-216 Residue by Distillation

ASTM International

D 3665-07e1 Standard Practice for Random Sampling of Construction Materials

American Association of State Highway and Transportation Officials (AASHTO)

T40-02 (2006) Sampling Bituminous Materials

308.03

DEFINITIONS

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

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.

Hot Mix Asphalt (HMA) means hot mixed, hot laid asphaltic concrete. The terms are used interchangeably. HMA may include recycled or specialty mixes.

Independent Laboratory means as defined in OPSS 313.

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 new HMA is laid.

Lot means a specific quantity of material or a specific amount of construction.

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 requirements specified in the Contract Documents.

Surface Course means the HMA wearing course of any flexible or composite pavement.

308.04

DESIGN AND SUBMISSION REQUIREMENTS

308.04.01

Submission Requirements

At least 5 Days prior to the first use of tack coat or joint painting material on the Contract, the Contractor shall submit documentation to the Contract Administrator identifying the proposed supplier and applicator of the product. With this, the Contractor shall submit material safety data sheets and any other information for the safe handling and storage of the product.

Proposals for the use of alternative tack coat and joint painting material, including the use of SS-1 emulsified asphalt with a dilution rate lower than 50%, shall be submitted in writing to the Contract Administrator at least 7 Days prior to the intended use of the alternate product.

The Contractor's proposal shall include the following:

- a) The reason for the use of the alternate material.
- b) Material safety data sheet 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 shall respond in writing within 5 Days of receiving it, with either accepting the use of the alternate product or not accepting its use with rationale. The alternate product shall not be used until the Contract Administrator has granted permission in writing.

308.05 MATERIALS

308.05.01 Tack Coat and Joint Painting Material

Tack coat and joint painting material shall consist of SS-1 emulsified asphalt diluted with an equal volume of water. The undiluted material shall be according to OPSS 1103.

308.06 EQUIPMENT

308.06.01 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 accuracy of the metering system shall be certified by the manufacturer and this certificate shall be made available to the Contract Administrator upon request. Alternatively, the metering system shall be accompanied by documentation confirming that it was calibrated within the past 12 months by the manufacturer, or its authorized representative, and such documentation shall be made available to the Contract Administrator upon request.

The use of a hand-held pressure applicator is acceptable for tack coating protection board and small irregularly shaped areas such as tapers.

308.06.02 Joint Painting Distributors

A hand-held pressure applicator shall be used for joint painting.

308.07 CONSTRUCTION

308.07.01 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. Tack coat shall be applied ahead of the paver to accommodate not more than 2 hours of production of HMA. Hot mix shall not be placed on tack-coated areas until the tack coat has cured to a proper condition of tackiness. Traffic shall be prevented from travelling upon the tack coat.

Tack coat shall be applied to the following:

- a) Protection board.
- b) Existing pavement surfaces including, but not limited to, hot mix and Portland cement concrete.
- c) Milled pavement surfaces.

- d) Expanded asphalt surface.
- e) Cold-in-place recycled surfaces.

and others as may be specified in the Contract Documents.

308.07.01.01 Tack Coat Rate of Application

The diluted emulsion shall be applied at the rate of 0.35 kg/m² 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/m². The rate of application on protection board shall be 0.50 kg/m².

When the Contractor's proposal to use an alternative tack coat product or dilution rate has been accepted, the application rates shall be in accordance with the submitted request.

308.07.02 Application of Joint Painting

Faces at which joints are made shall be painted with a thin, uniform, and continuous coating of joint painting material to the satisfaction of the Contract Administrator. The joint between pavement lanes paved in echelon is not required to be painted. The joint between pavement lanes paved with an infrared joint heater shall not be painted.

308.07.03 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

308.08 QUALITY ASSURANCE

308.08.01 General

The Contract Administrator shall determine the acceptability of tack coat and joint painting.

All visually defective material or work shall be rejected by the Contract Administrator irrespective of any test results. Such defective material and work shall not be incorporated into the finished work.

308.08.01.01 Basis of Product Acceptance

Acceptance of tack coat product shall be based on quality assurance test results conducted by the Owner's designated lab, subject to the conditions specified herein. Testing by a referee laboratory may be invoked by the Contractor.

For acceptance purposes, a minimum of one test for residue by distillation, percent by mass in accordance with LS-216, and one penetration test on the residue in accordance with LS-200 shall be performed by the Owner's QA laboratory on the diluted product for each subplot of tack coat. Test results shall be submitted to the Contractor as they become available to the Contract Administrator.

308.08.01.02 Laboratory Proficiency

The laboratory conducting the QA testing shall participate successfully in the MTO correlation program for emulsion testing prior to and during the time of paving.

308.08.01.03 Samples for Testing

Samples for testing shall be representative of the material being used and shall be obtained at the paving site in accordance with AASHTO T40 and ASTM D 3665. QA samples obtained for acceptance purposes and for referee testing shall be obtained at the paving site. All required samples for acceptance and referee purposes shall be acquired at the same time in locations selected by the Contract Administrator.

The minimum quantity of each of the QA and referee samples shall be 1 litre. The Contractor shall obtain, package, and transport all QA and referee samples to the Owner's designated QA laboratory. Only new containers shall be used for sampling purposes. QA and referee samples shall be delivered at the same time, in a condition suitable for testing, and within 2 Business Days of sampling.

308.08.01.04 Lot and Sublot Sizes

The entire quantity of tack coat used on the Contract shall be divided into one to three lots with one lot for each specified application rate. The lots shall be divided into sublots, typically comprising the quantity used to cover an area of 40,000 m². The Contract Administrator in consultation with the Contractor shall determine the actual sublot sizes. A sublot may be terminated at the Contractor Administrator's option when hot mix placement for the Contract ceases for a period of 20 Days.

308.08.01.05 Product Acceptance

Tack coat product acceptance is based on the results of the residue by distillation test according to LS-216 on the diluted product for each sublot, as well as the weighted mean of all such tests. The weighted lot mean for the product percent residue (WM_{pro}) shall be calculated using the following equation:

$$WM_{pro} = [(PR_1 \times A_1) + (PR_2 \times A_2) + \dots + (PR_n \times A_n)] / [A_1 + A_2 \dots + A_n]$$

Where:

PR _n	=	Percent Residue for sublot n
A _n	=	the area of sublot n
n	=	the number of sublots

The percent residue by distillation for each sublot shall not be less than 20% for the result to be included in the calculation of the weighted mean. Sublots with percent residue less than 27.5% shall be accepted into the work, with a payment reduction determined using WM_{pro} and Table 1.

308.08.01.06 Referee Testing

Testing by an independent laboratory for the percent residue is available to the Contractor for any sublot of tack coat.

Referee testing may only be invoked if the Contractor has taken and delivered all referee samples in a condition suitable for testing. In addition, referee testing shall be permitted only if it is invoked within 2 Business Days of the Contractor receiving the test results for the sublot in question.

If referee testing is requested, the referee laboratory shall be designated by the Contract Administrator from a list maintained by the Owner for this purpose. The Contract Administrator shall arrange for the transfer of all referee samples to be tested to the referee laboratory.

The results of the referee testing shall be binding on both parties and shall be used in the calculation of the payment factor. The cost of the referee testing is specified elsewhere in the Contract. It shall be borne by the Contractor if the percent residue as determined by the referee laboratory is less than 27.5%.

308.08.01.07 Acceptance

308.08.01.07.01 Acceptance of Tack Coat Application Rate

The acceptance of tack coat application rate shall be based on settings determined by the Contractor of the equipment on the pressure distributors. When requested, such settings shall be verified by the Contract Administrator.

Tack coat application shall be visually uniform. Areas of insufficient or non-uniform tack coat coverage shall be re-sprayed by the Contractor at no additional cost to the Owner. Where 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.

308.08.01.07.02 Acceptance of Joint Painting Application Rate

The joint painting shall provide a thin, uniform, and continuous coating to the satisfaction of the Contract Administrator.

308.09 MEASUREMENT FOR PAYMENT

308.09.01 Plan Quantity Payment

308.09.01.01 Tack Coat

Measurement shall be by Plan Quantity Payment by area in square metres.

308.10 BASIS OF PAYMENT

308.10.01 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, except that payment for joint painting shall be made under the appropriate hot mix tender item.

Payment for tack coating of concrete surfaces completed in association with bridge deck waterproofing shall be included in the bridge deck-waterproofing item. Payment for tack coating of the protection board shall be paid under the tack coat item.

The payment reduction for each lot of tack coat shall be calculated using the following equation:

Payment Reduction = Total area tack coated x Price x 0.5 [1.00 - Product Payment Factor]

No payment shall be made for sublots with percent residue less than 20%. The results for the remaining sublots in the lot shall be analyzed for the weighted mean for the product percent residue and the product quality payment factor determined from Table 1.

The price shall be the tender item price for the specified product or the negotiated price of the alternate product, if the Owner accepted the use of that product.

TABLE 1
Product Quality Payment Factors

% Residue - Weighted Lot Mean (WM_{pro})	Product Quality Payment Factor
≥ 27.5	1.00
20.0 - 27.4	0.75

Appendix 308-A, April 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

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR HOT MIX ASPHALT - END RESULT

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313.01 SCOPE

This end result specification covers the requirements for the placement, compaction, and acceptance of hot mix asphalt.

313.01.01 Specification Significance and Use

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

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

313.01.02 Appendices Significance and Use

Appendices are not a mandatory part of this specification unless invoked by the Owner.

Appendix 313-A is a commentary appendix to provide designers with information on the use of this specification in a Contract.

313.02 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.

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

Ontario Provincial Standard Specifications, Construction

OPSS 308 Tack Coat

Ontario Provincial Standard Specifications, Material

OPSS 1101 Performance Graded Asphalt Cement
OPSS 1151 Superpave and Stone Mastic Asphalt Mixes

Ministry of Transportation Publications

MTO Laboratory Testing Manual:

LS-100 Rounding - off of Test Data and Other Numbers
LS-101 Calculation of Per Cent Within Limits
LS-264 Theoretical Maximum Relative Density of Bituminous Paving Mixtures
LS-282 Quantitative Extraction of Asphalt Cement and Analysis of Extracted Aggregate from Bituminous Paving Mixtures
LS-291 Quantitative Extraction of Asphalt Cement and Mechanical Analysis of Extracted Aggregate from Bituminous Paving Mixtures - Ontario Procedure
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
LS-604 Relative Density And Absorption Of Coarse Aggregate
LS-605 Relative Density And Absorption Of Fine Aggregate

ASTM International

D 6752-03 Standard Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Automatic Vacuum Sealing Method
E 178-02 Standard Practice for Dealing With Outlying Observations

American Association of State Highway and Transportation Officials (AASHTO)

M 320-02	Standard Specification for Performance Graded Asphalt Binder
R 28-06	Practice for Accelerated Aging of Asphalt Binder Using Pressurized Aging Vessel (PAV)
R 35-04	Superpave Volumetric Design for Hot - Mix Asphalt
T 166-05	Bulk Specific Gravity of Compacted Bituminous Mixtures Using Saturated Surface-Dry Specimens
T 240-06	Effect of Heat and Air on a Moving Film of Asphalt (Rolling Thin Film Oven Test)
T 305-97(2001)	Determination of Draindown Characteristics in Uncompacted Asphalt Mixtures
T 312-04	Standard Method of Test for Preparing and Determining the Density of Hot-Mix Asphalt (HMA) Specimens by Means of the Superpave Gyratory Compactor
T 313-05	Flexural Creep Stiffness of Asphalt Binder Using the Bending Beam Rheometer (BBR)
T 315-06	Rheological Properties of Asphalt Binder Using Dynamic Shear Rheometer (DSR)

National Asphalt Paving Association

NAPA IS-127 Evaluation of Baghouse Fines for Hot Mix Asphalt

National Center for Asphalt Technologies

NCAT Report 9-8/4 Designing Stone Matrix Asphalt Mixtures Volume IV - Mixture Design Method, Construction Guidelines, and Quality Control Procedures

313.03 DEFINITIONS

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

Ambient Air Temperature means the air temperature measured in the shade and away from the paving operations.

AMRL means the AASHTO Materials Reference Laboratory.

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, VMA, draindown, 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.

Class R Roller means self-propelled pneumatic-tired rollers.

Class S Roller means self-propelled steel-drum, tandem, or three-wheel rollers.

Class V Roller means 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.

Designated Large Sieve (DLS) means a sieve size specifically designated for each mix type for gradation testing. The designated sieve for the following mix types is as follows:

25.0 mm	for Superpave 37.5
19.0 mm	for Superpave 25.0
12.5 mm	for SMA 19.0, Superpave 19.0
9.5 mm	for SMA 12.5, Superpave 12.5, 12.5FC 1 and 12.5FC 2
4.75 mm	for SMA 9.5, Superpave 9.5

Draindown means that portion of SMA mixture, fines, and asphalt cement that separates and flows downwards through the mixture.

Fat Spot means an area of pavement substantially blacker than the surrounding pavement.

Field Adjustment to the JMF means a change in the target gradation, asphalt cement content, or both of a mix, within limits specified without a redesign of the HMA, resulting in a revised JMF.

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 a 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 a HMA surface course placed over localized areas of distressed pavement, generally for the purpose of improving strength, rideability, or safety.

Independent Laboratory means a third party laboratory that is not owned or corporately affiliated with the laboratory that prepared the mix design or with the Contractor.

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 mixture that are based on specified mix design procedures.

Joint means a vertical contact between a HMA pavement course and any HMA pavement or any rigid object that exists at the time the HMA is laid.

Levelling Course means a 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.

Loose Mix means a sample of HMA obtained using plates or other approved means for testing mix properties.

Lot means a specific quantity of Material or a specific amount of construction.

Mean means the arithmetic average of the test results within a lot.

Medium Segregation means the pavement has significantly more coarse aggregate particles than the surrounding acceptable mat and usually exhibits some lack of surface matrix.

Micromilling means the use of a milling machine to restore the riding characteristics of a HMA pavement.

Mid-Lane Segregation means a continuous or discontinuous longitudinal "streak", typically no greater than 300 mm in width located anywhere across the width of the lane.

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 voids.

Other Segregation means discrete areas or patches of regular, irregular or chevron shape.

Outlier means a test result that for a specific significance level is determined by statistical analysis not to be part of the test result population.

Paving in Echelon means two or more pavers are used to pave multiple adjacent lanes simultaneously.

Payment Adjustment Sieves means the DLS, 4.75 mm, 600 µm, and 75 µm aggregate gradation sieves.

Per Cent Within Limits (PWL) means an estimate of the percentage of the lot that is within specification limits, determined by using the mean and standard deviation of the lot.

Performance Graded Asphalt Cement (PGAC) means an asphalt binder that is produced from petroleum residue, either with or without the addition of non-particulate modifiers, according to AASHTO M 320.

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 requirements specified in the Contract Documents

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 requirements specified in the Contract Documents.

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 subplot 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.

Recycled Hot Mix Asphalt (RHM) means an HMA that contains RAP or RST or both.

Roof Shingle Tabs (RST) means ground roof shingle scrap generated when new shingles are trimmed during production.

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.

Severe Segregation means the pavement appears very coarse, with coarse aggregate particle against coarse aggregate particle and the pavement has little or no matrix.

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.

Standard Deviation means the square root of the value determined 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.

Stone Mastic Asphalt (SMA) means HMA consisting of a gap graded, stone-on-stone coarse aggregate skeleton with an asphalt cement-rich mortar.

SMA Mixes means SMA 9.5, SMA 12.5, and SMA 19.0.

Stone Mastic Asphalt (SMA) Mortar means a mixture of asphalt cement and any additives; filler, including all material passing the 0.075 mm sieve from the dry sieving of all aggregate components, including any commercial filler; and fibres blended by volume to the proportions required by the JMF.

Straight Edge means a straight edge made of metal with a level recessed in its upper surface parallel to the lower edge.

Superpave means the method for specifying material components and asphalt mixture design using the Superpave gyratory compactor (SGC).

Surface Course means the HMA wearing course of any flexible or composite pavement.

Through Lane means a traffic lane not intended for entering or exiting the roadway and does not include shoulders. Where there is more than one roadway, through lane refers to the traffic lane for the higher-class roadway.

Vertical Surface means all edges of concrete curbs, catch basins, appurtenances, longitudinal joints, and transverse joints for application of joint painting material.

Voids means air voids and voids in mineral aggregate (VMA).

Voids in Mineral Aggregate (VMA) means the intergranular void space between the aggregate particles in a compacted paving mixture that includes the air voids and the effective asphalt cement content, expressed as a percent of the total volume.

313.04 DESIGN AND SUBMISSION REQUIREMENTS

313.04.01 Submission Requirements

Prior to hot mix asphalt production, the Contractor shall inform the Contract Administrator whether LS-291, LS-282, or LS-292 shall be used for QC testing in writing and shall not change the method without providing written notification to the Contract Administrator in advance.

Prior to the start of paving, the Contractor shall submit to the Contract Administrator the purchase price of the asphalt cement in the form of a purchase order or other document signed by the Contractor's senior financial officer.

Prior to the start of paving on bridge decks, the Contractor shall provide to the Contract Administrator the mass of the rollers, except for Class V rollers, used on bridge decks in writing.

313.05 MATERIALS

313.05.01 Hot Mix Asphalt

The Materials used in the production of HMA shall be according to OPSS 1151.

313.05.02 Tack Coat

The Materials shall be according to OPSS 308.

313.06 EQUIPMENT

313.06.01 General

A 3 m straight edge that has been approved by the Contract Administrator shall be provided on each paver.

313.06.02 Rollers

The Contract Administrator may require that rollers used on bridge decks be weighed in his presence.

Petroleum based release agents, excess water, or excess release agents shall not be permitted.

313.06.03 Smoothness Measuring Device

Only measuring devices with current approval by the Owner shall be used.

313.06.04 Diamond Grinder

A diamond grinder shall be power-driven, self-propelled, and designed for grinding 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 ensure that the HMA is removed to the desired dimensions and shall also include a slurry pick-up system.

313.06.05 Milling Machine

A milling machine shall be equipped with a specialized milling drum fitted with 450 to 500 carbide bits spaced approximately 5 mm apart.

313.07 CONSTRUCTION

313.07.01 Quality Control

QC procedures shall be conducted to ensure HMA meets the requirements of the Contract Documents. The Contractor shall be responsible for the interpretation of the QC inspections, test results, and measurements 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.

All QC testing shall be performed in a laboratory that has current CCIL Type B Certification for Superpave mixes, or is an AMRL accredited or equivalent laboratory. In addition, the laboratory carrying out the testing shall participate in the Ministry's correlation programs for gyratory compactors, which occur just prior to and during the paving operations. All QC testing shall be done by and under the direct and constant supervision of a Superpave certified technician, certified by CCIL or an equivalent organization.

RAP shall be considered as an aggregate for the purposes of process control.

313.07.02 Laboratory Correlations

At the Contractor's request, the Contract Administrator shall provide the Contractor with the opportunity to conduct a correlation of aggregate densities, mix properties, VMA, and compaction between the QA and QC laboratories prior to placement of HMA, once for each mix type.

The Contractor shall provide the Contract Administrator with all of the test results obtained by the QC laboratory. The Contract Administrator shall provide the QA correlation test results to the Contractor after receiving QC correlation test results and on completion of the correlation testing.

313.07.03 Preparation of Foundation and Existing Pavement

Prior to placing any course of HMA on:

- a) a granular grade, a Class S roller with a minimum mass of 7 tonnes and minimum mass of 3.5 kg per mm total roll width 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, float-free surface free from contamination of foreign materials. This roller shall operate within 300 m of the paver.
- b) HMA or concrete surfaces, the HMA and concrete surfaces shall be cleaned of all loose, broken, and foreign materials.
- c) milled surfaces, the milled surface shall be cleaned of all loose, broken, and foreign materials and shall be swept with a power broom.

313.07.04 Tack Coat

Tack coat shall be applied to surfaces according to OPSS 308 prior to placing HMA.

313.07.05 Transportation of Hot Mix Asphalt

Truck boxes used to transport HMA shall be clean and, if required, lightly coated with a uniform application of a non-petroleum based release agent. Truck boxes must be drained after each application and before loading. No release agents shall be used that may adversely affect the quality or performance of the HMA. Release agents shall be used according to the proprietary requirements.

313.07.06 Placing Hot Mix Asphalt

313.07.06.01 Operational Constraints

Paving shall not be carried out if the roadbed is frozen. When placing the mixture on a granular grade, the granular grade shall not be saturated and shall be free of standing water. The surface of a pavement upon which HMA is to be placed shall be clean and dry at the time of HMA placement.

An HMA course shall not be placed upon 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 50 °C or less. HMA binder courses shall be not placed unless the ambient air temperature is at least 2 °C. For surface course, the ambient air temperature shall be at least 7 °C except for SMA and Superpave 12.5FC 2 the ambient air temperature shall be at least 12 °C.

The Contractor shall not allow traffic to travel between pavers operating within 300 m of each other.

313.07.06.02 Paving

Levelling, binder, and surface courses shall be laid by means of mechanical self-propelled pavers. 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.

After final compaction of each course the surface shall be smooth and true to the established crown and grade, uniform in texture and shall be free of any defects including segregation, fat spots, oil spills, and roller marks.

All through lane paving courses shall be completed prior to the placement of adjacent sideroads, speed change lanes, and other paved areas.

At the end of each completed portion of the lanes and prior to opening them to traffic, the ends of completed sections of HMA course shall be temporarily ramped down to the existing pavement at a slope of 120H:1V transversely. Longitudinal ramp downs shall only be permitted if specified in the Contract Documents. Transverse and longitudinal ramps downs shall not form part of the permanent pavement and shall be removed prior to paving of the adjacent section.

If paving is being carried out under lane closures, paving shall be completed to the same station for the full pavement width, including paved shoulders, prior to the roadway being reopened to traffic. If, due to unforeseen circumstances such as equipment breakdown occurring during paving, the Contractor can not complete paving to the same station across the full pavement width, the Contractor shall construct a temporary longitudinal ramp down at 10H: 1V. The temporary ramp down shall be removed and the adjacent lane paved within 1 Day or as agreed to by the Contract Administrator in the event of weather or access restrictions.

313.07.07 Paving in Echelon

Paving in echelon shall be as specified in the Contract Documents.

The pavers shall be operated at the same time within 60 m of the next paver so that a hot joint is obtained between the lanes of HMA being placed. Should one paver break down while placing levelling, binder, or surface course, the Contract Administrator may permit the day's work to be completed with the remaining paver only.

313.07.08 Widening and Irregular Sections

The HMA shall be placed in widenings such that the top of the compacted HMA is flush with the top of the existing pavement. When stepped joints are specified, 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.

In turnouts, driveways, and other irregular sections, the Contractor may use other methods to spread and finish the HMA.

313.07.09 Longitudinal and Transverse Joints

313.07.09.01 General

All joints shall be made to ensure a complete bond is obtained between the two pavement edges and that the riding surface is smooth. Longitudinal and transverse joints between the new HMA pavement and the existing pavement shall be butt or stepped joints as specified in the Contract Documents. 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.

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.

313.07.09.02 Longitudinal Joints

Longitudinal joints shall be properly set up, with the back of a rake or lute, at proper height and grade prior to rolling. Excess Material shall not be cast onto the surface of the freshly laid mat.

The width of subsequent courses shall be staggered to an offset of 150 to 300 mm so that longitudinal joints do not coincide. The longitudinal joints in the surface course shall correspond to the demarcation between the lanes specified in the Contract Documents.

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.

313.07.09.03 Transverse Joints at Limits of Paving

Joints between HMA pavement laid under this Contract and existing HMA courses not laid under the Contract shall be constructed as follows:

- a) Where 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) Where a surface course is placed flush against an existing HMA pavement, a butt joint shall be prepared by removing the existing pavement to the full depth of the existing surface course, to form a straight vertical face, and for a longitudinal distance not less than 5.0 m so that the surface course placed has a thickness equal to the full depth of the existing surface course over the 5 m section.
- c) Where a binder course and surface course are not placed flush against an existing HMA pavement, the binder course shall be feathered out removing the existing surface course to a minimum depth of not less than 40 mm, to form a straight vertical face, and for a longitudinal distance not less than 5 m so that the surface course placed has a minimum thickness of 40 mm over the 5 m section.

313.07.10 Paving on Bridge Decks

The temperature of the HMA immediately after spreading shall not be less than 115 °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.

313.07.11 Compaction

Compaction of the HMA shall be conducted using appropriate methods and equipment to provide a uniformly compacted mat according to the requirements of this Contract. Class R rollers shall not be used to compact SMA.

At all places not accessible to rollers, the HMA shall be compacted by mechanical self-powered gas-, electric-, or air-powered equipment.

313.07.12 Review of Work

313.07.12.01 Surface Tolerances

The Contractor shall carry out surface tolerance measurements for QC using a 3 m straight edge. The Contractor may be required at any time to take additional surface tolerance measurements in the presence of the Contract Administrator or his representative at their request.

313.07.12.02 Surface Appearance

The Contractor shall review each course after final compaction and identify any visual deficiencies.

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.

313.07.13 Field Adjustments to the Job Mix Formula

All field adjustments to the JMF are subject to the conditions specified herein.

The revised JMF shall be supplied in writing on a form supplied by the Contract Administrator together with supporting test results. Within 1 Business Day of receiving the new JMF documentation, the Contract Administrator shall give a written confirmation of receipt of the revised JMF to the Contractor confirming conformance to the contract requirements or advising of any non-conformance. The revised JMF may be applied to the lot being placed at the time the confirmation of receipt of the revised JMF is issued and the previous lot, if requested by the Contractor as part of the written submission for a JMF change. If this request is not made, the revised JMF shall only apply to mix placed subsequent to the acceptance of the revised JMF.

A field adjustment to the JMF shall be permitted under three situations:

- a) To more closely reflect the actual mix being produced, when test results for the last lot produced to the submitted JMF accrued a payment reduction for asphalt cement content or aggregate gradation or both but met all other specified mix requirements. The test results (lot mean) shall show that the design requirements for VMA, percent G_{mm} at N_{max} , VFA, and dust proportion were met, and that there was no payment reduction for air voids.
- b) To permit minor changes in the constituent proportions, when test results for the last lot produced to the submitted JMF indicated no negative price adjustments for asphalt cement or gradation, but changes are designed to improve either the air voids or the VMA or both. For this situation, the air voids PWL shall be at least 50 and the lot mean VMA shall be no more than 0.50% below the design minimum.
- c) To permit minor changes in the submitted JMF before production starts.

In all cases, the Contractor shall submit test results to support the application for the change to the JMF. For situation a), this shall be for a minimum of one lot with all its sublots. For situation b), the mean of test results for a minimum of four samples of mix produced in support of this application shall be submitted which shall confirm that the proposed JMF shall produce mix that shall conform to the contract requirements for air voids and VMA, and that the proposed mix shall continue to conform to the percent G_{mm} at the initial and maximum

number of gyrations, VFA, and dust proportion. For situation b) or c), in lieu of plant check data, results of tests carried out on laboratory mixed samples are acceptable. A minimum of six gyratory-compacted specimens, four compacted to the design number of gyrations and two compacted to the maximum number of gyrations, is required. A minimum of two determinations for maximum theoretical density shall be performed.

The number of field adjustments to the JMF shall be limited to two for each mix design submitted for a given tender item. Field adjustments to the JMF shall be limited in scope such that the net impact of all field adjustments to the JMF does not exceed any of the maximum field adjustments to the JMF in Table 1 in comparison to the original JMF submitted under the current mix design.

313.07.14 Revision to Submitted Mix Design

Submission of a revised mix design is permitted prior to placing any HMA for a tender item when the Contractor determines that aggregate densities in the original mix design have changed but the material sources and proportions are unchanged. A written request shall be made that shall be accompanied by the revised mix design submission clearly showing the more recently determined aggregate density test results and the mix properties obtained with the newly established aggregate density, and with replicate referee and QA aggregate samples. The mix design laboratory shall carry out testing using the protocol for a mix check specified above, except that the mix design laboratory shall use its own density results to determine volumetric properties, and the Mix Check Requirements according to OPSS 1151, does not apply to the mix design laboratory's results. The mix design laboratory results for the revised mix design shall meet all mix design requirements, except that the percent air voids at the design number of gyrations shall be 4.0 ± 0.3 .

The independent laboratory shall conduct a mix check and provide a completed certification MTO Form PH-CC-822IMC, Certificate of Independent Check of Mix Design, for the revised mix design as specified in the Contract Documents. Results of testing carried out by the mix design laboratory in support of the revision and the certification form for the revised mix design shall be submitted with the revised mix design. Within 4 Business Days commencing after the day of delivery of all required documents and all samples, the Contract Administrator shall provide, in writing, the above confirmation or advise the Contractor of any Contract requirements that have not been met. Production shall not begin until the Contract Administrator has issued written confirmation that the revised submission meets Contract requirements.

313.07.15 Sampling

313.07.15.01 Asphalt Cement

Samples of the asphalt cement shall be taken according to OPSS 1101.

313.07.15.02 Hot Mix Asphalt Aggregates for Density Testing

The Contractor shall procure samples for RAP, RST, and the aggregates identified in the mix design for each mix type using methods specified in the Contract Documents. The first set of samples shall be taken no later than 10 Days prior to the start of production of the first lot of HMA. Subsequent samples shall be taken immediately following the completion of 15,000 tonnes $\pm$ 1,000 tonnes of mix production, and thereafter at further intervals of 20,000 tonnes as required. The aggregate, RAP, and RST sampling program shall be established in consultation with the Contract Administrator prior to paving. If the Contractor determines that a sampling interval needs to be reduced to reflect changes in the aggregate properties, the Contract Administrator shall be notified and samples shall be taken as warranted.

Each sample shall be clearly identified as to the date of sampling, the lot number, and the item hot mix tonnage being produced when the sample was taken.

313.07.15.03**Hot Mix Asphalt Mix Properties**

Samples shall be appropriately labelled with the Contract number, highway number, Region, lot number, subplot number, mix type, lift number, station, offset from the centreline of the highway, and date and time of sampling.

The Contract Administrator shall advise the Contractor of each random sample location or the tonnage from which the sample is to be taken. A set of three samples shall be taken as per Table 2. One of these samples shall be for the Contractor's QC testing and the other two shall be designated for QA and referee testing.

Samples shall be obtained on site from the same truckload and at the same transverse offset. When the mass of the sample does not meet the requirements of Table 2, the sample shall be discarded and a new one taken immediately. The transverse location of the new sample shall be the same as that of the discarded one.

The SMA sample for draindown testing shall coincide with one of the other subplot samples as designated by the Contract Administrator. The samples shall be transferred to a clean stainless steel bowl or pan of suitable size, immediately after splitting, for delivery to the testing laboratory.

313.07.15.04**Compaction**

Upon completion of each subplot, the Contract Administrator shall inform the Contractor of each random sample location in writing. The Contractor shall obtain pavement core samples in triplicate, from each subplot no later than the next Working Day after the completion of the subplot. Each core shall have a minimum nominal diameter of 150 mm and a maximum nominal diameter of 200 mm 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.

When the lift thickness of the pavement core is less than 35 mm, the core shall be submitted to the Contract Administrator and a replacement core shall be extracted at a location within the same subplot selected by the Contract Administrator. If the thickness of the replacement core is also less than 35 mm, the Contractor shall submit the core to the Contract Administrator and review the situation with the Contract Administrator prior to any further coring of the subplot.

Core samples shall also include design lift thickness on the label and the lot and subplot numbers shall be clearly marked with a permanent marker on all compaction cores.

HMA and compaction requirements for filling the 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.

313.07.15.05**Stone Mastic Asphalt**

Once each week during production of SMA, the Contractor shall provide a summary and appropriate supporting documentation, including bills of lading, that reconciles the daily usage of fibres and mineral filler in the mix with the quantity of SMA produced.

The Contractor shall obtain a set of three samples of mineral filler and fines returned to the mix according to Table 2. One of these samples shall be for the Contractor's QC SMA Mortar testing and for the Contractor to test for Rigden Voids and the other two samples shall be designated for QA and referee testing. Lots shall consist of mineral filler and returned fines incorporated in 10,000 tonnes of SMA produced. Each lot shall consist of one subplot.

313.07.16 Testing

313.07.16.01 Submission of Test Results

The Contractor shall submit all test results to the Contract Administrator not later than 2 Business Days after sampling each subplot for HMA mix properties and compaction and 5 Business Days for density testing of the HMA aggregates.

313.07.16.02 HMA Aggregates for Density Testing

The Contractor shall conduct density tests for RAP, RST, and aggregates identified in the mix design for each mix type using methods specified in the Contract Documents and also report the resulting combined aggregate density for the purpose of determining the VMA of the mix.

Density testing of the coarse and fine aggregates shall be carried out according to LS-604 and LS-605 respectively using the procedures for blended aggregates. The resulting combined aggregate density for each set of samples shall represent the aggregates incorporated in up to 20,000 tonnes of HMA or all the full lots of mix within this tonnage, as established in the sampling program. All test results shall be provided to the Contract Administrator within 5 Business Days of sampling the aggregates, RAP, and RST.

313.07.16.03 Hot Mix Asphalt Properties and Compaction

The Contractor shall conduct tests, carry out calculation and provide values according to Table 3.

313.07.16.04 Surface Smoothness

The Contractor shall measure all through lane pavement surfaces using an approved smoothness-measuring device as specified in the Contract Documents, with the following exceptions:

- a) Where the posted speed is 60 km/hour or less.
- b) Where a single lift is placed on an existing surface.
- c) Within 10 m of the end of a placement where the paving Contractor is not responsible for the adjoining surface.
- d) Bridge decks and within 10 m of bridge deck expansion joints.
- e) Detours and other temporary pavement that shall be removed or overlaid under this Contract.
- f) The first adjacent lane consisting of one or more lifts of hot mix where the Contractor must match to an existing surface that is not being resurfaced under this Contract.
- g) Within 10 m of any access holes, water valves, or similar structures which are located within the lane or within 1.5 m of the outside edge of the lane.

313.07.17 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

313.08 QUALITY ASSURANCE

313.08.01 Acceptance Criteria

Acceptance of hot mix shall be based on the following criteria:

- a) Asphalt cement physical requirements
- b) Mix properties, VMA and compaction
- c) Surface tolerance
- d) Surface appearance
- e) Surface smoothness

313.08.01.01 Asphalt Cement Physical Requirements

The Contract Administrator shall determine the acceptability of the performance graded asphalt cement according to OPSS 1101.

313.08.01.02 Mix Properties, Voids in Mineral Aggregate, and Compaction

313.08.01.02.01 Lot Size

The Contract Administrator shall determine the size and location of the lots and sublots, including the optional trial, after discussion with the Contractor and before HMA production for the tender item starts. Guidelines for the breakdown of the tender item quantity into lots are as listed in Table 4.

When the tender item quantity is 1,000 tonnes or less, the subplot sizes shall be based on individual circumstances. When the tender item quantity is between 1,000 tonnes and 5,000 tonnes of hot mix, the quantity shall normally be considered as a single lot. The number or size of the sublots may be adjusted to suit the quantity. When the tender item quantity is 5,000 tonnes or more, the lot size shall normally be 5,000 tonnes with ten sublots of equal size. The lot and subplot sizes may be reduced, at the discretion of the Contract Administrator and after discussion with the Contractor, prior to placing the lot.

When the hot mix tender item is 5,000 tonnes or more, an optional trial of one lot, not exceeding 500 tonnes, with one subplot shall be permitted for the tender item. If the Contractor elects to plan this optional trial, he shall advise the Contract Administrator in writing prior to placing the trial lot. The optional trial shall be placed in a binder course and shall not be placed in a critical location such as bridge decks. Before placing any SMA as surface course, an optional trial consisting of a quantity of up to 1,000 tonnes is permitted. The optional trial may be divided into two to three sections in the upper binder, with each section being considered as a separate lot for sampling and testing, as specified in the Contract Documents.

When only one or two sublots are completed at the end of paving for the tender item due to a change in the JMF or when a delay of more than 20 Business Days occurs in placing the complete lot, the test results obtained shall be considered as part of the previous lot and the previous lot shall then have 11 or 12 sublots. When the optional trial is the previous lot and only one or two sublots are completed as described above, they shall be evaluated for acceptance in the same manner as for the optional trial. When only 3 to 9 sublots are completed due to the above circumstances, then the 3 to 9 sublots shall be considered as a lot.

When a delay of more than 20 Business Days occurs in placing the complete lot and this lot shall be completed during the same calendar year, the Contractor may, prior to the end of the 20 Business Days, request in writing to the Contract Administrator that the lot be continued upon the resumption of paving for that tender item. If the request is not made or is not accepted by the Contract Administrator, the lot shall be terminated and evaluated for acceptance.

313.08.01.02.02**Comparison of Test Results and Impacts**

The QA and referee laboratories shall use the same test method as the Contractor except that when the Contractor chooses LS-292, the QA and referee laboratories shall use that method provided the calibration requirements are met. If they are not met, the affected laboratory shall use LS-282.

QA testing shall be for comparison purposes only except as allowed for in Use of QA Results for Payment clause, and shall be based on a minimum frequency of one test result generated by the QA laboratory for every two results generated by the QC laboratory. The Contract Administrator shall provide the Contractor with a copy of the test results.

On receiving the QC test results for the lot, the compaction payment factor and the mix properties payment factor for the lot, shall be calculated by the Contract Administrator. If no QA testing is carried out, the QC results shall be used for acceptance of HMA, unless either party requests referee testing. If QA testing is carried out, the QC and QA results shall be compared by the Contract Administrator on a lot-by-lot basis, and the following shall apply:

- a) The QC and QA results shall be deemed to agree, if the difference in the compaction payment factor and the mix properties payment factor calculated using the QA and QC test results are both less than 0.025. When the QC and QA results agree, the payment factor obtained using the QC results shall apply unless either party requests referee testing.
- b) If the above comparison criterion is not met, the QC and QA results shall be deemed to disagree, and either party may request referee testing.

The Contract Administrator shall compare SMA air void test results. If a QA subplot or a QA lot are rejectable for air voids and the corresponding QC subplot or QC lot was not rejectable, the Owner may request referee testing.

For aggregate density testing, when the difference in the combined aggregate densities determined through QA and QC testing is less than or equal to 0.010, the QC value shall be used for the purposes of calculating the VMA of the HMA. If this difference is between 0.011 and 0.020, the value used for calculating the VMA shall be the mean of the QC and QA densities. When the QC and QA combined aggregate densities are different by more than 0.020, the result shall be deemed to be in disagreement and referee testing shall be invoked by the Owner to determine the combined aggregate density. The value determined by the referee laboratory shall be used to calculate the VMA of the mix.

313.08.01.02.03**Basis of Acceptance**

Acceptance for all mixes for mix properties and compaction is based on the lot PWL for each attribute, excluding VMA and except that for SMA the air voids PWL is determined for information purposes only. The PWL of the lot for each criteria shall be used to determine the payment adjustment factor from Table 5, based on PWL. If the PWL is less than 50% for asphalt cement content, air voids or compaction, or less than 25% for any payment adjustment sieve, the lot is rejectable and shall be subject to repair or payment adjustment. VMA shall meet the minimum mix design requirements according to OPSS 1151 for each lot and payment shall be based on the lot mean as specified in the Payment Factor for Voids clause. If the VMA payment factor is less than 0.500, the lot shall be considered rejectable. SMA lots shall be considered rejectable if the draindown is more than 0.3%.

When the tendered item quantity is less than 1,000 tonnes, the HMA may be accepted by the Contract Administrator based upon such testing as is deemed necessary by the Contract Administrator to determine substantial conformance with the Contract. When three or more tests have been completed for a lot the Material shall be accepted at the full Contract price, subjected to a payment adjustment or rejected as detailed herein.

The optional trial shall not be subject to payment adjustment unless the mix is rejectable. To determine if the mix is rejectable for the optional trial, the asphalt cement content, aggregate gradation, air voids, and compaction shall comply with the limits specified in Table 6.

The Contract Administrator shall determine if a rejectable lot may remain in the work without repairs. When the Contract Administrator has determined that a rejectable lot may remain in the work without repair, the lot shall be subjected to a payment adjustment. If the Contractor elects to repair the lot in lieu of a payment adjustment or if the Contract Administrator determines that a rejectable lot requires repair, the lot shall be repaired and re-evaluated as detailed under repairing and re-evaluating.

313.08.01.02.03.01 Interim Procedure for Administration of Air Voids Requirements for Stone Mastic Asphalt

A lot shall be considered acceptable for air voids, if the mean of the test results within that lot is greater than or equal to 2.5 percent and less than or equal to 5.5 percent and no subplot has a test result less than 2.0 percent or greater than 6.0 percent air voids.

A lot shall be considered rejectable, if the mean of all of the test results within that lot is either less than 2.5 percent or greater than 5.5 percent air voids.

A subplot shall be considered rejectable, if its test result is less than 2.0 percent or greater than 6.0 percent air voids.

For lots or sublots that are rejectable with respect to air voids and that the Contract Administrator requires repaired, the Contractor shall provide a written proposal to the Contract Administrator with the details of how the repairs shall be carried out.

313.08.01.02.03.02 Stone Mastic Asphalt Mortar Properties

SMA mortar shall be considered acceptable on a lot-by-lot basis, if the SMA mortar meets the following requirements as determined according to Table 3:

Unaged Dynamic Shear Rheometer, $G^*/\sin\delta$ - 5 kPa minimum

RTFO Aged Dynamic Shear Rheometer, $G^*/\sin\delta$ - 11 kPa minimum

PAV Aged Bending Beam Rheometer - 1,500 MPa maximum

The SMA mortar shall be blended by volume using a portion of the lot asphalt cement and mineral filler and baghouse fines samples to the proportions used in the mix design.

313.08.01.02.04 Referee Testing

313.08.01.02.04.01 General

The Contractor or the Contract Administrator may request testing by an independent third party referee laboratory for the entire lot for any completed lot, regardless of the difference in QC and QA payment factors. All referee testing shall meet the conditions associated with one of the categories identified in Table 8.

Either party may request referee testing for determining the draindown of a SMA sample.

Referee testing for a given lot can only be invoked by the Contractor within 5 Business Days of the Contractor receiving the Contract Administrator's calculated payment factors for that lot. The Owner may invoke referee testing for a given lot not more than 15 Business Days after all the QA samples for the lot are received at the QA laboratory, or not more than 15 Days after a lot is terminated due to a delay of more than 20 Business Days in placing the complete lot, whichever is the latest date.

The results generated by the referee laboratory shall be used to re-evaluate the lot to determine the payment factors for the acceptance of the disputed properties for the disputed lots of HMA.

313.08.01.02.04.02 Referee Voids in Mineral Aggregate

When the QA combined aggregate density is within 0.020 of the QC combined aggregate density, the aggregate densities shall be deemed to be in agreement and the referee laboratory shall use the QC combined aggregate density in calculating the VMA. If the mean QC and QA combined densities are not in agreement, the referee laboratory shall conduct aggregate density testing on samples supplied to it for this purpose. These samples shall be the last samples taken prior to the start of the lot being subjected to referee testing. The combined aggregate density result shall be compared to the QC and QA combined aggregate density results, and the referee calculation of VMA shall be based on the result that is closer to the referee result. The referee result shall only be used if it is exactly in between the QC and QA combined aggregate density test result.

313.08.01.02.05 Outliers

313.08.01.02.05.01 Determination of Outliers in Test Results

The Contractor or the Contract Administrator may question an individual value for any attribute of a subplot's test result, excluding VMA. The request shall be made within 3 Business Days of the Contractor and Contract Administrator receiving all of the test results for the lot and only when the payment factor for the attribute with an outlier is less than 1.0. The validity of the questioned attribute shall be ascertained in accordance with ASTM E 178 using a T test at a 10% significance level.

If the T test procedure shows that the questioned value of the attribute is not an outlier, then the test result shall be used in the calculations. If the T test procedure shows that the questioned value of the attribute is an outlier, then the test result for the subplot shall be checked for mathematical errors.

For QC and QA test results, if there are no mathematical errors, the test result for the subplot is also considered an outlier and shall be discarded and replaced. For referee test results, if there are no mathematical errors, the subplot with the outlier is treated as a lot with one subplot and the remaining sublots shall form a separate lot as detailed in Outlier in Referee Results clause.

313.08.01.02.05.02 Quality Control and Quality Assurance Outlier Replacement Testing

When requested by the applicable party as specified in the Outlier in Quality Control Results and the Outlier in Quality Assurance Results clauses, a laboratory designated by the Owner from the Owner's roster of referee laboratories shall perform outlier replacement testing for QC and QA test results to replace the discarded test result using the referee sample. Outlier replacement testing shall be performed for a subplot for all mix properties or compaction or both (i.e., if one mix attribute is an outlier, all mix property results for that subplot shall be replaced, not just the attribute identified as an outlier). Regardless of the presence of outliers in the replacement test result for the subplot and remaining original results, the replacement test result shall be binding on both the Contractor and the Owner and further outlier replacement testing shall not be performed on the lot.

313.08.01.02.05.03 Outlier in Quality Control Results

For an outlier in the QC results, one of the following actions shall be taken:

- a) The Contractor may replace the outlier result with the Owner's QA result, either mix properties or compaction, for the affected subplot, if the Owner tested that sample.
- b) The Contractor may request that the Contract Administrator arrange for the Owner's laboratory to test the corresponding QA sample for that subplot.

- c) The Contractor may request that a replacement result for the outlier be obtained by testing of the referee sample for the subject subplot. If the Contractor or Owner were to subsequently request referee testing on the full lot, the same lab that performed the outlier replacement testing would be assigned as the referee lab, and the results of the replacement testing already completed for the subject subplot shall also become the referee results for that subplot.

313.08.01.02.05.04 Outlier in Quality Assurance Results

For an outlier in the QA results, the Contractor or the Contract Administrator may request that a replacement result for the outlier be obtained by testing of the referee sample for the subject subplot. If the Contractor or Owner subsequently requested referee testing on the full lot, the same laboratory that performed the outlier replacement testing shall be assigned as the referee laboratory, and the results of the replacement testing already completed for the subject subplot shall also become the referee results for that subplot. The cost of the outlier replacement testing shall be borne by the party requesting the outlier replacement testing, unless the entire lot subsequently undergoes referee testing, in which case, the referee testing for the entire lot shall be paid according to the referee testing procedure specified in the Contract Documents.

313.08.01.02.05.05 Outlier in Referee Results

When an outlier in the referee results is identified, the subplot with the outlier shall be treated as a lot with one subplot for both mix properties and compaction or air voids, when only air voids was subject to referee testing, and compaction for SMA.

When the subplot with the outlier is treated as a lot with one subplot, the remaining sublots shall form a separate lot.

The lot with one subplot shall be evaluated as follows:

A single test result for each attribute shall be used to evaluate the lot.

If the outlier value and the other attributes for the subplot are within the specification limits listed in Table 6, then the payment factor shall be 1.00 for the lot.

If the outlier value or any of the attributes used to evaluate the lot is rejectable (i.e., outside the specification limits listed in Table 6) or the outlier value and any of the attributes used to evaluate the lot is rejectable, then the lot is rejectable. The Contract Administrator may assess a payment reduction or require that the lot be repaired at the Contractor's expense as specified in the Repairing and Re-evaluating clause. If a rejectable lot is allowed to remain in the work, a payment factor of 1.00 shall be given to each attribute that is not rejectable, and the payment factor for PWL = 50%, 25% for each sieve analysed for gradation, from Table 5 based on PWL, shall be given to each attribute that is rejectable. The total payment factor for the lot shall be calculated using the formulae detailed in the Calculations clause.

The lot formed by the remaining sublots shall:

- a) be accepted, subjected to a payment adjustment or rejected as detailed elsewhere in the Contract Documents for lots with 3 or more sublots, and
- b) not be checked for further outliers.

If only two sublots remain, the two sublots shall be treated as two separate lots each with one subplot.

313.08.01.02.05.06 Use of Quality Assurance Results for Payment

At the Contractor's request, made in writing to the Contract Administrator within 2 Business Days of receiving the initial set of QA test results for the lot from the Contract Administrator, the use of the Owner's QA results for payment purposes shall be permitted on a lot-by-lot basis. When the Contract Administrator grants the Contractor's request in writing, all of the following actions shall apply:

- a) All the remaining untested QA samples in the lot shall be tested by the QA laboratory and used with the initial set of QA test results to determine the payment factors.
- b) The QA test results in the lot and the calculated payment factors shall be binding on both the Owner and the Contractor.
- c) Referee testing cannot be invoked by either the Owner or the Contractor for the subject lot.

313.08.01.02.06 Repairing and Re-Evaluating

The Contract Administrator may require any rejectable lot to be repaired. When the Contract Administrator has determined that a rejectable lot may remain in the work without repair, the lot shall be subjected to a payment adjustment.

The Contractor may elect to carry out repairs in lieu of accepting a payment adjustment, if the lot is not rejectable and the total payment factor for the lot is less than 0.940. When the Contract Administrator requires a rejectable lot to be repaired or the Contractor elects to carry out repairs in lieu of accepting a payment adjustment, the Contractor shall determine what areas of hot mix in a lot are to be repaired subject to the minimum lengths and widths specified herein. Each repair area shall include at least one of the loose mix or core sample locations or both representing that subplot.

The minimum length of a single-repair to one lane shall be 250 m. The minimum length of a single-repair that extends over more than one lane shall be 250 lane-metres and no portion of the single-repair in a lane shall be less than 125 m in length.

The minimum limits of each repair shall be at least 125 lane-metres from the location of the loose mix or compaction core or both that represents the subplot; otherwise, a repair limit shall coincide with one end of the subplot when the sample location is less than 125 lane-metres from it. If the proposed limit of a single-repair falls within the proposed limit of another single-repair, the overlap shall count towards the 250 lane-metre minimum for both repairs. Repair areas within a single lane shall be separated by at least 100 m. If the delineation of repair areas results in patches less than 100 metres apart, these repair areas shall be re-established to form a continuous repair.

The Contractor shall submit a list and sketch identifying the proposed locations of the repairs to the Contract Administrator for review at least 5 Business Days prior to the intended start of the repair work. Each subplot and single-repair shall be uniquely labelled. Overlapping repair areas and discontinuous portions of a single-repair shall be labelled so that they are readily identified with their single-repair. The Contractor shall not start repairs unless the Contract Administrator has given written permission. If permission is denied, then the Contract Administrator shall provide the Contractor with the reason in writing.

Prior to the repair, the Contractor shall take slab samples or cores for testing of AC Content, Gradation, Air Voids, and VMA or Compaction or all in the unrepaired area within 1 m of the limits of each end of the repair area. The Contractor shall not be permitted to take additional samples or cores beyond these locations until after QC, QA, or referee testing demonstrates that the remaining Material in the subplot proposed for repair is deemed to be rejectable. If the proposed repair limit coincides with the beginning of a subplot that is being left unrepaired, samples are not required at this location. Sufficient material shall be obtained for testing by the QC laboratory, the Owner's QA laboratory, and for possible referee testing.

Testing shall demonstrate that the remaining Material in the subplot proposed for repair is not rejectable. To determine if the mix is rejectable, the asphalt cement content, aggregate gradation, air voids, and compaction shall comply with the limits specified in Table 6. If the Material is deemed to be rejectable, the proposed limit of the repair shall be extended by a minimum of 25 m, and the sampling and testing repeated. The repair area selected by the Contractor shall incorporate the location used for obtaining samples that shall be used to confirm that the remaining mix is not rejectable. If the contractor's repair proposal results in the removal of at least half the subplot tonnage, the Contract Administrator may waive testing demonstrating the suitability of the remainder of that subplot.

Repair shall consist of the removal and replacement of the full thickness of the hot mix lift or the placement of an overlay when permitted by the Contract Administrator. The minimum width of repair shall be the width of the lane or shoulder or both being repaired. A paver shall be used in carrying out the repair.

When repairs are made to all or part of a lot, the lot shall be re-evaluated. The unrepaired sublots combined with the remainder of any repaired sublots shall comprise one lot and shall be assessed on the basis of the loose mix or core or both samples representing the unrepaired sublots. If there are only one or two sublots in a lot that are not repaired, the Contract Administrator shall include those sublots as part of the previous or next lot. When the referee laboratory has tested the lot, the referee test results shall be used to determine the payment factors instead of the original test results.

The mix used for the repair shall comprise a separate lot or the Contract Administrator in conjunction with the Contractor may decide to include it as part of the current lot being produced. The repaired area shall be tested for all criteria.

The 2 reconfigured lots shall be accepted at the full Contract price, subjected to a payment adjustment or rejected according to the Payment Adjustment for Mix Properties and Compaction clause.

313.08.01.02.07 Specification Limits

PWL shall be determined using lot test results, LS-101, and lower and upper limits specified in Table 6 and Table 7.

313.08.01.03 Surface Tolerance

The surface tolerances of any pavement surface shall be such that when tested with a 3 m straight edge placed anywhere, including the edge of the pavement, in any direction on the surface, except across the crown or drainage gutters, there shall not be a gap between the bottom of the straightedge and the surface of the pavement:

- a) greater than 6 mm for all binder courses and padding, or
- b) greater than 3 mm for all surface courses.

All areas not meeting the surface tolerance requirements shall be repaired by diamond grinding or removed and replaced. Slurry produced from diamond grinding shall be removed from the site by the Contractor and managed as specified in the Contract Documents.

313.08.01.04 Surface Appearance

HMA deemed by visual appearance to have flushing, bleeding, segregation, fat spot, surface damage, and surface contamination but not limited to these, shall all be considered deficient Material or work. Deficient material, mixture, and work shall be removed and replaced or repaired or assessed a payment reduction as directed by the Contract Administrator.

313.08.01.04.01 Segregation

The Contractor shall provide traffic control, for all segregation assessments and to resolve all segregation challenges, regardless of the type, location, causes, or severity.

313.08.01.04.02 Disposition of Segregated Mix

HMA exhibiting medium or severe midlane segregation shall be assessed a payment reduction or shall be repaired at the discretion of the Contract Administrator.

Other segregation shall be addressed in accordance with the following:

- a) Slightly segregated mix shall be accepted into the work with no payment reduction.
- b) Medium segregation in binder, levelling, and padding courses with a thickness no less than 40 mm, shall normally be left in place with no payment reduction. However, any areas of medium segregation that deteriorate prior to being overlaid by another pavement course shall be repaired at no cost to the Owner. Medium segregation in surface courses shall be assessed a payment reduction, or repaired at the direction of the Contract Administrator.
- c) All severely segregated mix shall be repaired by removal and replacement.

Levelling or padding courses with a total thickness that is less than 40 mm, bullnoses, and tapers that were not machine-laid and any areas of handwork shall not be assessed on the basis of segregation but on the basis of other workmanship-related problems. However, if they deteriorate prior to being overlaid by another pavement course, the Contract Administrator shall assess the causes of the deterioration before determining responsibility for the cost of repairs.

313.08.01.04.03 Challenging Severity of Segregation

The Contractor may challenge, in writing, the severity of any segregated area assessed as either medium or severe, within 5 Business Days of receiving the Owner's first visual assessment. The written challenge shall list the dimensions and the Contractor's assessment of the severity of each disputed area.

For contracts with up to 30,000 tonnes of HMA, the Contractor shall be allowed a maximum of two separate written challenges for each tender item. However, for contracts with more than 30,000 tonnes of HMA, the Contractor shall be allowed a maximum of four separate written challenges for each tender item. Each written challenge may involve more than one disputed segregated area.

A representative of the Owner who is qualified in segregation assessment, who did not carry out the original assessment and who is not the Contract Administrator shall make a second visual assessment of the disputed areas. This second visual assessment shall be carried out within 5 Business Days after the Contract Administrator has received the Contractor's written challenge and the results of that second visual assessment shall be binding on both the Owner and Contractor.

313.08.01.04.04 Repairs for Segregation

All repairs shall be subject to the approval of the Contract Administrator. Repairs shall consist of removal and replacement with new HMA that meets the contract requirements for the tender item. All repaired areas shall be tack-coated and all transverse joints in surface course repairs shall butt up to a vertical face. A paver shall be used for all repairs except those where localized repairs are allowed. Repairs for segregated HMA shall be full lane or full shoulder width. Where the Contract Administrator permits localized repairs for mid-lane segregation in binder courses, these repairs shall be:

- a) less than or equal to 300 mm in width;
- b) to the full depth of the subject lift; and
- c) tack-coated.

313.08.01.05 Acceptance Criteria for Smoothness

The acceptability of smoothness shall be as specified in the Contract Documents.

313.09 MEASUREMENT FOR PAYMENT

313.09.01 Actual Measurement

313.09.01.01 SMA 19.0
 SMA 12.5
 SMA 9.5
 Superpave 4.75
 Superpave 9.5
 Superpave 12.5
 Superpave 12.5FC 1
 Superpave 12.5FC 2
 Superpave 19.0
 Superpave 25.0
 Superpave 37.5

313.09.01.01.01 By Area

Measurement of HMA shall be the horizontal area in square metres in place.

313.09.01.01.02 By Mass

Measurement of HMA shall be by mass in tonnes according to the requirements of the Contract Documents.

Measurement of HMA used for temporary ramping specified in the Contract Documents shall be measured in tonnes. Removal of temporary ramping specified in the Contract Documents shall not be measured for payment.

313.09.01.02 Hot Mix Asphalt Miscellaneous

Measurement of HMA Miscellaneous shall be by area in square metres, regardless of the number of lifts placed.

313.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement is based on the units shown in the clauses under Actual Measurement.

313.10 BASIS OF PAYMENT

313.10.01 Hot Mix

**313.10.01.01 SMA 19.0 - Item
SMA 12.5 - Item
SMA 9.5 - Item
Superpave 4.75 - Item
Superpave 9.5 - Item
Superpave 12.5 - Item
Superpave 12.5FC 1 - Item
Superpave 12.5FC 2 - Item
Superpave 19.0 - Item
Superpave 25.0 - Item
Superpave 37.5 - Item**

Payment at the Contract price for the above tender items, including the applicable payment adjustments, shall be full compensation for all labour, Equipment, and Materials to do the work.

When repairing HMA, 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.

When the Contract Administrator instructs the Contractor to cease paving 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.

313.10.01.02 Payment Adjustment for Mix Properties and Compaction

For all mixes, when the Contractor is not required to or does not elect to repair a lot, the payment adjustment for that lot due to mix properties and compaction requirements shall be:

$$PA_{MC} = \text{lot quantity} \times \text{price} \times [PF_{MC} - 1.000] \quad (\text{Formula 1})$$

For all mixes, when the PF_{MC} is:

- a) less than 1.000, there shall be a reduction in payment;
- b) equal to 1.000 there shall be no adjustment; and
- c) greater than 1.000 there shall be an increase in payment for the lot.

Where:

Lot Quantity shall be the quantity of the mix in the lot. For SMA 19.0, SMA 12.5, SMA 9.5, Superpave 12.5FC 1, and Superpave 12.5FC 2 the lot quantity is the quantity of the mix in the lot multiplied by the applicable mass multiplier factor (MF) in the Payment Adjustment for Aggregate Density clause.

Price for the purposes of payment adjustment due to mix properties and compaction, means the contract price of the hot mix tender item. In the case where surface mix is placed as an optional trial in the binder course, the term price means the contract price for the surface course tender item. If asphalt cement content is specified for bidding purposes, the term price means the adjusted contract price after adjusting for the change in asphalt cement content.

313.10.01.02.01 Optional Trial

If the Contractor has elected to place an optional trial as detailed in the Lot Size clause, the lot shall be assigned a PF_{MC} of 1.000 if the lot is not rejectable. If the lot is determined to be rejectable, it shall be administered as described in this specification. If a rejectable lot is allowed to remain in the work, a payment factor of 1.000 shall be given to each attribute that is not rejectable, and the payment factor for $PWL = 50\%$, 25% for each sieve analysed for gradation, from Table 5 shall be given to each attribute that is rejectable. The PF_{MC} for the lot shall be calculated using the formulae detailed in the Calculations clause.

313.10.01.02.02 Calculations

313.10.01.02.02.01 General

The PF_{MC} shall be based on the individual payment factors obtained from Table 5, based on PWL , determined for gradation, asphalt cement content, voids, and compaction using LS-101 and the formulae in the Payment Factor for Gradation clause, the Payment Factor for Combined Gradation and Asphalt Cement Content clause, the Payment Factor for Voids clause, the Payment Factor for Combined Mix Properties clause, and the Payment Factor for Combined Mix Properties and Compaction clause.

When there is no sampling or testing specified for an attribute or when the requirement for sampling or testing for an attribute is waived by the Owner, the payment factor for that attribute shall be equal to either:

- a) the payment factor it is added to in Formulae 8, 13, or 16, if that payment factor is less than 1.0; or,
- b) 1.0, if the payment factor it is added to in Formulae 8, 13 or 16 is equal to or greater than 1.0.

313.10.01.02.02.02 Payment Factor for Gradation

To obtain the gradation payment factor use the following formulae:

For Superpave 37, Superpave 25, Superpave 19, Superpave 12.5, Superpave 12.5FC 1, Superpave 12.5FC 2, SMA 19, and SMA12.5:

$$PF_{G(SUB)} = PF_{DLS} + PF_{4.75} + PF_{600} + PF_{75} \quad (\text{Formula 2})$$

If $PF_{G(SUB)}$ is greater than or equal to 4, the equation for PF_G is $PF_G = PF_{G(SUB)} - 3$ (Formula 3)

If $PF_{G(SUB)}$ is less than 4, the equation for PF_G is $PF_G = PF_{G(SUB)} / 4$ (Formula 4)

For Superpave 9.5, Superpave 4.75, and SMA 9.5 $PF_{G(SUB)} = PF_{4.75} + PF_{600} + PF_{75}$ (Formula 5)

If $PF_{G(SUB)}$ is greater than or equal to 3, the equation for PF_G is $PF_G = PF_{G(SUB)} - 2$ (Formula 6)

If $PF_{G(SUB)}$ is less than 3, the equation for PF_G is $PF_G = PF_{G(SUB)} / 3$ (Formula 7)

Where:

PF_G = payment factor for gradation

PF_{DLS} = payment factor for designated large sieve

$PF_{4.75}$ = payment factor for the 4.75 mm sieve

PF_{600} = payment factor for the 600 μm sieve

PF_{75} = payment factor for the 75 μm sieve

313.10.01.02.02.03 Combined Gradation And Asphalt Cement Content

To obtain the combined gradation and asphalt cement content payment factor use the following formulae:

$$PF_{GAC(SUB)} = PF_G + PF_{AC} \quad (\text{Formula 8})$$

If $PF_{GAC(SUB)}$ is greater than or equal to 2, then

$$PF_{GAC} = PF_{GAC(SUB)} - 1 \quad (\text{Formula 9})$$

If $PF_{GAC(SUB)}$ is less than 2, then

$$PF_{GAC} = PF_{GAC(SUB)} / 2 \quad (\text{Formula 10})$$

Where:

PF_{AC} = payment factor for asphalt cement content

PF_{GAC} = combined payment factor for asphalt cement content and gradation

313.10.01.02.02.04 Payment Factor for Voids

For Superpave mixes, if the lot mean VMA is not more than 0.5 percent below the minimum VMA specified for mix design purposes, the payment factor for VMA is 1.000. For lot mean VMA results more than 0.5 percent lower than the minimum specified for mix design purposes, a payment factor for the subject lot shall be calculated in accordance with the following:

$$\text{If } (VMA_{min} - VMA_{mean}) \geq 2.5, \text{ then } PF_{VMA} = 0 \quad (\text{Formula 11})$$

$$\text{If } (VMA_{min} - VMA_{mean}) < 2.5 \text{ then, } PF_{VMA} = 0.8000 - 0.4(VMA_{min} - 0.5 - VMA_{mean}) \quad (\text{Formula 12})$$

Where:

PF_{VMA} = payment factor for VMA

VMA_{mean} = lot mean VMA

VMA_{min} = minimum VMA specified for mix design

For Superpave mixes when the payment factor for VMA is less than 1.000, it shall be compared to the payment factor for air voids and the lesser of the two is the payment factor for voids, PF_{VOIDS} . When the Payment Factor for VMA is equal to 1.000, PF_{VOIDS} shall be the same as the payment factor for air voids.

For SMA, the payment factor for air voids as determined by Table 5, Payment Adjustment Factors based on PWL, shall not be used in the combined payment factor.

For SMA, although sampling and testing for air voids are required, for the purposes of payment factor calculation, air voids for SMA shall be treated as an attribute where sampling or testing or both has been waived by the Owner. However, the Owner shall be given all QC test results for air voids as well as all other attributes specified in the Contract Documents.

$$PF_{VOIDS} = PF_{GAC} \text{ if } PF_{GAC} < 1.000, \text{ or } PF_{VOIDS} = 1.000 \text{ if } PF_{GAC} \geq 1.000$$

313.10.01.02.02.05 Payment Factor for Combined Mix Properties

To obtain the combined payment factor for mix properties, PF_M use the following formulae:

$$PF_{M(SUB)} = PF_{GAC} + PF_{VOIDS} \quad (\text{Formula 13})$$

If $PF_{M(SUB)}$ is greater than or equal to 2 then

$$PF_M = PF_{M(SUB)} - 1 \quad (\text{Formula 14})$$

If $PF_{M(SUB)}$ is less than 2 then

$$PF_M = PF_{M(SUB)} / 2 \quad (\text{Formula 15})$$

313.10.01.02.02.06 Pay Factor for Combined Mix Properties and Compaction

To obtain the combined payment factor for mix properties and compaction (PF_{MC}) use the following formulae:

$$PF_{MC(SUB)} = PF_C + PF_M \quad (\text{Formula 16})$$

$$\text{If } PF_{MC(SUB)} \text{ is greater than or equal to 2 then } PF_{MC} = PF_{MC(SUB)} - 1 \quad (\text{Formula 17})$$

$$\text{If } PF_{MC(SUB)} \text{ is less than 2 then } PF_{MC} = PF_{MC(SUB)} / 2 \quad (\text{Formula 18})$$

Where:

PF_C = Compaction Payment Factor

The PF_{MC} shall be reported to four decimal places with rounding in accordance with LS-100.

For SMA, if a subplot is considered rejectable for air voids and the Contract Administrator allows the Contractor to leave the subplot unrepaired, then the lot which contains that subplot shall only be allowed to receive a maximum PF_{MC} of 1.000. However, when the Contractor repairs a subplot due to rejectable air voids, then only the tonnage within that subplot shall not be allowed to receive a PF_{MC} greater than 1.000.

When the Contract Administrator decides that the unrepaired area of an original lot that has been partially repaired shall not be resampled, the PF_{MC} for the unrepaired area shall be 1.000.

313.10.01.03 Payment Adjustment for Surface Smoothness

Payment adjustment for surface smoothness shall be as specified in the Contract Documents.

313.10.01.04 Payment Adjustment for Segregated HMA

For each continuous lane-kilometre of mainline surface course, starting at the beginning of paving and the area at the end of the Contract that is less than one lane kilometre in length, the Contractor shall receive a payment increase of \$0.50 per tonne for Superpave 12.5FC 2 and where Superpave 12.5FC 1 is used on freeways in Northeastern Region or \$0.20 per tonne for any other mix types as long as these areas do not have:

- a) mid-lane segregation;
- b) more than one area of slight, other segregation, which is no more than 8 m² in size;
- c) medium or severe other segregation; or
- d) other significant visual deficiencies, as specified in the Contract Documents,

before repairs have been made for visual deficiencies. Transfer lanes on freeways and freeway-to-freeway interchange ramps, excluding any hand-laid areas at the ends, which meet the above-listed restrictions for visual deficiencies, shall also be eligible for payment increases.

The Contract Administrator shall calculate the theoretical tonnage of surface course that shall receive a payment increase. Theoretical tonnage shall be calculated using the design widths and depths for each lane-kilometre of mainline paving, including any paved shoulder up to 0.5 m in width which is being placed at the same time and using the same paver as the finished lane, and the mean lot average bulk relative density calculated from all of the values obtained from compaction acceptance testing of core samples for the applicable surface course.

For all surface courses, where payment reductions for segregation are allowed in lieu of repairs, the Contractor shall be assessed a payment reduction of:

- a) \$2,000 once for each applicable surface course tender item regardless of the existence of payment increases;
- b) an additional payment reduction of \$2.50/m for mid-lane segregation; and
- c) an additional payment reduction of \$5.00/m² for other segregation. The area of each patch shall be computed by multiplying the full lane width by the length of the patch and rounded to the next whole square metre.

Payment under the appropriate tender item shall include full compensation for traffic control required to conduct all segregation assessments and to resolve all challenges. However, if under a challenge, as described in the Challenging Severity of Segregation clause, the Contractor is successful, then the Owner shall pay for the cost of the traffic control for the second visual assessment, if the traffic control was not necessary for any other reason. The Owner shall not be held liable for any associated costs such as delays to the Contractor.

313.10.01.05 Payment Adjustment for Aggregate Density

For Superpave 12.5FC 1, Superpave 12.5FC 2, SMA 19.0, SMA 12.5, and SMA 9.5, the tender quantity is based on reference densities (D_R) according to Table 9. A payment adjustment for aggregate density, (PA_{AD}) for each lot for these tender items shall be determined by the following formulae:

$$MF = D_R / (BRD_{mix}) \quad (\text{Formula 19})$$

$$PA_{AD} = M_{mix} \times \text{Contract Price} \times [MF - 1.000] \quad (\text{Formula 20})$$

Where:

MF = the mass multiplier factor calculated to 3 decimal places

D_R = the reference density in t/m³, as specified in Table 9

BRD_{mix} = the lot average bulk relative density in t/m³, calculated from values obtained in the testing of bulk samples obtained during production. The values shall be the same as those used in calculating the final air voids payment factor for the lot.

M_{mix} = the weighed mass of the mix in the lot incorporated into the work

Contract Price = the Contract price of the tender item for the mix.

For all mixes, when the mass multiplier factor is:

- a) less than 1.000, there shall be a reduction in payment
- b) equal to 1.000, there shall be no adjustment
- c) greater than 1.000, there shall be an increase in payment for the lot

313.10.01.06 Payment Adjustment for Asphalt Cement Content

The payment adjustment shall apply to the calculated mass of HMA placed using the JMF.

Subject to the conditions specified below for the particular mixes, the payment adjustment for asphalt cement content, PA_{AC} shall be calculated using the following formula:

$$PA_{AC} = M_{tmix} \times [\text{Adjusted Contract Price} - \text{Contract Price}]$$

When unit of measure is tonnes:

M_{tmix} = Weighed mass of the HMA accepted into the work

When unit of measure is square metres:

M_{tmix} = Mass of HMA accepted into the work calculated by the Contract Administrator using the design widths and depths of pavement area and HMA density. Density used in the calculation of

M_{tmix} shall be 97.5% of the bulk relative density determined from the mix design.

There shall be an adjustment to the contract price if the percentage by mass of asphalt cement required for the work as required by the JMF differs from that specified for bidding purposes.

$$\text{Adjusted Contract Price} = \text{Contract Price} + [\text{PRICE}_{AC} \times (\text{AC}_{JMF} - \text{AC}_{BID})/100]$$

PRICE_{AC} = the purchase price per tonne of the asphalt cement used in the mix

AC_{JMF} = the percentage by mass of asphalt cement required for the work as required by the JMF

AC_{BID} = the percentage by mass of asphalt cement specified for bidding purposes

The percentage by mass of new asphalt cement, % NEWAC incorporated into the HMA shall be the difference between the percentage by mass of asphalt cement required by the JMF and the percent by mass of asphalt cement contained in the RAP incorporated into the HMA, as determined by the Contract Administrator.

Contract Price = the unit price of the tender item for the mix when the unit of measurement is tonnes. When the unit of measurement is square metres, the Contract Administrator shall convert contract price to the equivalent price per tonne.

313.10.02 Anti-Stripping Additives

Payment at Contract price for the applicable HMA tender item shall be full compensation for all Labour, Equipment, and Materials required to test, supply, and incorporate the anti-stripping additives.

313.10.03 Hot Mix Asphalt Miscellaneous - 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 except that the HMA Material shall be paid for under the appropriate HMA tender item.

313.10.04 Tack Coat

Where there is no separate tender item for tack coat, payment at the Contract price for the applicable HMA tender item to be placed on the tack coat shall be full compensation for all labour, Equipment, and Materials for the tack coating.

313.10.05 Repair

No payment shall be made for the:

- a) quantity of HMA that is removed and replaced, overlaid, or otherwise repaired; or
- b) for additional shouldering, traffic control and other work such as zone painting or bridge deck waterproofing,

when:

- a) in lieu of a reduction in payment, the Contractor repairs the lot, subplot, or visually defective HMA; or
- b) the Contract Administrator has determined that a rejectable lot or subplot requires repair.

The Contractor shall be charged for all additional testing resulting from a repair to a lot at the rates established by the Owner for the year in which the testing was carried out.

313.10.06 Outlier

313.10.06.01 Outlier in Quality Control Results

When there is an outlier in the QC Results and the Contractor requests the Contract Administrator arrange for the Owner's laboratory to test the corresponding subplot QA sample, the cost of the additional testing carried out by the QA laboratory shall be the Contractor's responsibility. The Contractor shall be charged at the rate of \$200 per subplot for mix samples and \$75 per subplot for compaction samples.

When there is an outlier in the QC Results and the Contractor requests that a replacement result for the outlier be obtained by testing of the referee sample for the corresponding subplot, the cost of the outlier replacement testing shall be borne by the Contractor, unless the entire lot subsequently undergoes referee testing, in which case the referee testing for the entire lot shall be paid according to the referee testing procedure specified in the Contract Documents.

313.10.06.02 Outlier in Quality Assurance Results

The party requesting outlier replacement testing shall bare the cost of the outlier in QA results replacement testing, unless the entire lot subsequently undergoes referee testing, in which case the referee testing for the entire lot shall be paid according to the referee testing procedure specified in the Contract Documents.

313.10.07 Referee Testing for Mix Properties and Compaction

When QC and QA results do not agree, for any referee testing which is carried out without an outlier in the referee results, the cost of referee testing, including sample delivery, shall be borne by the party whose payment factor is further removed from that generated by the referee laboratory. However, if the payment factor determined by the referee results is exactly in between that determined by the QC and QA laboratories, the cost of the referee testing shall be split between the Owner and the Contractor.

If the QC and QA results agree, the cost of referee testing, including sample delivery, shall be borne by the party requesting the referee testing.

When the QC and QA results for the original lot did not agree and there is an outlier in the referee test results, the Contractor shall be charged 50% of the total cost for referee testing, including sample delivery, of all sublots in the original lot.

The cost of referee testing shall be based on the referee testing rates specified in Table 10.

TABLE 1
Maximum Field Adjustments For JMF

JMF PROPERTIES	MAXIMUM FIELD ADJUSTMENT % (Notes 1 and 2)
Asphalt cement content (all mixes except SMA mixes)	± 0.2
Asphalt cement Content - SMA mixes only	± 0.4
Percent RAP	- 5.0
Percent passing 26.5 mm, 25.0 mm, 19.0 mm, and 16.0 mm sieves	± 5.0
Percent passing 13.2 mm, 12.5 mm, and 9.5 mm sieves	± 4.0
Percent passing 4.75 mm, 2.36 mm, and 1.18 mm sieves	± 3.0
Percent passing 600, 300, and 150 µm sieves	No limits
Percent passing 75 µm sieve (all mixes except SMA mixes)	± 1.0
Percent passing 75 µm sieve - SMA mixes only	± 2.0
Notes: 1. The maximum field adjustment is applied against the original JMF submitted with the mix design. 2. The revised JMF shall meet the requirements of the Contract, including asphalt cement content and gradation on all sieves.	

TABLE 2
Sample Size and Frequency

Material	Mass of Production Samples (Note 1) (kg)	Frequency of Sampling
SMA mixes, Superpave 9.5, 12.5, 12.5FC 1, 12.5FC 2, and 19.0	20 to 30 or 30 to 40 (Notes 2 and 3)	Every subplot
Superpave 25.0 and 37.5	25 to 35 or 35 to 45 (Notes 2 and 3)	Every subplot
SMA mixes for draindown testing	3 to 5	Once per lot
Mineral filler and baghouse fines used in SMA mixes	1 (Note 4)	Once every 10,000 tonnes
Notes: - Each material sample receptacle shall have a maximum mass of 30 kg. - The larger sample size shall be applicable when samples are designated for testing to the maximum number of gyrations. The frequency of the larger samples shall be two per lot, as designated by the Contract Administrator. For ease of handling, especially when the larger sample size is required, splitting of material at the paving site is permitted such that a sample is contained in a maximum of two receptacles whose total mass does not exceed the maximum specified above. Once delivered to testing laboratories, combining of the material from the two receptacles is only mandatory if a single receptacle contains insufficient material to carry out the full suite of tests required. - One set of cores, with each core a minimum thickness of 35 mm. - Commercial mineral filler and baghouse fines shall be combined in the same proportions used in the mix design.		

TABLE 3
Testing Requirements

Properties and Attributes	Testing Method	Calculations, Values, and Results Required
Mix Properties		
Asphalt Cement Content and Aggregate Gradation for mix samples	LS-291, LS-282, or LS-292	% AC % passing DLS sieve 4.75 mm sieve 600 µm sieve 75 µm sieve
Volumetric Properties		
Laboratory Compaction to: i. Design number of gyrations (N_{des}) ii. Maximum number of gyrations (N_{max}) Maximum Theoretical Specific Gravity (G_{mm})	AASHTO T 166 using the same laboratory compaction protocol as was used in mix design. (Note 1) AASHTO T 312, LS-264 Superpave Mixes only: in addition to compacting all samples to the design number of gyrations, two samples from each lot of HMA shall be compacted to the maximum number of gyrations.	Bulk Relative Density for mix samples, BRD_m BRD at N_{des} BRD at N_{ini} BRD at N_{max} G_{mm} % G_{mm} @ N_{ini} % G_{mm} @ N_{des} % G_{mm} @ N_{max}
Voids in Mineral Aggregate, VMA	LS-604, LS-605, AASHTO R 35 (Note 2)	VMA
Voids Filled with Asphalt, VFA	AASHTO R 35	VFA
Air Voids for mix, V	Calculate using BRD_m , MRD_m Where: $V = 100(1 - BRD_m / MRD_m)$ $MRD_m = G_{mm}$	Percent air voids, V
Dust to Binder Ratio, DP for Superpave mixes	Calculate as the ratio of dust, % passing the 75 µm sieve by mass of aggregate, to effective asphalt cement content	DP
Compaction		
Compaction and Thickness of Cores	BRD_c = Bulk Relative Density at N_{des} and N_{ini} for core samples (BRD_c) LS-262 (Notes 1 and 3). MRD_c = Maximum Relative Density for core samples, LS-264. % Compaction = $(100 \times BRD_c / MRD_c) + C$ C = Thickness Correction factor, 0.1% for each whole millimetre that the individual pavement core thickness is less than 40 mm	BRD_c MRD_c Thickness of Core % Compaction
SMA Mix Properties		
Draindown for mix	AASHTO T 305	% draindown
Rigden Voids for SMA Filler	NAPA IS 127	Rigden Voids
SMA Mortar Properties	The asphalt cement used shall be RTFO aged according to AASHTO T 240 and PAV aged according to AASHTO R 28 prior to blending with fillers. SMA mortar shall be blended and tested according to the draft test method, Standard Practice for Testing of HMA Mortars AASHTO Format, of NCAT Report 9-8/4. Mortar with unaged and RTFO aged PGAC shall be tested using the Dynamic Shear Rheometer according to AASHTO T 315 at the average 7-day maximum pavement design temperature of the appropriate asphalt cement grade according to AASHTO M 320. Mortar with PAV aged PGAC shall be tested using the Bending Beam Rheometer according to AASHTO T 313 at the minimum pavement design temperature of the appropriate asphalt cement grade according to AASHTO M 320.	Unaged Dynamic Shear Rheometer, $G^*/\sin\delta$ RTFO Aged Dynamic Shear Rheometer, $G^*/\sin\delta$ PAV Aged Bending Beam Rheometer, Stiffness
Notes:		
- For all gyratory-compacted specimens and cores of SMA mixes and Superpave mixes, if the percent water absorbed by the specimen is found to exceed 2% by volume, as described in AASHTO T 166, then the bulk relative density shall be determined using either LS-306 or ASTM D 6752. The method of testing cores or laboratory compacted specimens shall not be changed without the written consent of the Contract Administrator. - Calculate to two decimal places for each subplot using the BRD_m for the subplot, and the combined aggregate densities of the blended coarse and blended fine aggregate, as specified in this specification, to provide a lot mean VMA to one decimal place. - The Contractor shall identify the method of test used with the results of first set of QC cores tested for a particular mix type. If the method of test is different from that used for laboratory compacted specimens, the Contractor shall provide written confirmation of this to the Contract Administrator, stating the reason for the difference.		

TABLE 4
Breakdown of the Tender Item Quantity Into Lots

Number Of Tonnes In Tender Item	Number Of Lots
< 5,000	1
5,000 to 10,000	2
10,000 to 12,000	2 or 3 (Note 1)
> 12,000	3 +
Note: 1. As determined by the Contract Administrator in consultation with the Contractor.	

TABLE 5
Payment Factors Based on Per Cent Within Limits

PWL	Designated Large Sieve	4.75 mm Sieve	600 µm Sieve	75 µm Sieve	AC Content	Air Voids (Note 1)	Compaction (Note 2)
100	1.0025	1.0025	1.0025	1.0025	1.010	1.020	1.030
99	1.002	1.002	1.002	1.002	1.008	1.013	1.024
98	1.0015	1.0015	1.0015	1.0015	1.006	1.007	1.018
97	1.001	1.001	1.001	1.001	1.004	1.000	1.012
96	1.0005	1.0005	1.0005	1.0005	1.002	1.000	1.006
95	1.000	1.000	1.000	1.000	1.000	1.000	1.000
94	1.000	1.000	1.000	1.000	1.000	1.000	1.000
93	1.000	1.000	1.000	1.000	1.000	1.000	1.000
92	1.000	1.000	1.000	1.000	1.000	1.000	1.000
91	1.000	1.000	1.000	1.000	1.000	1.000	1.000
90	1.000	1.000	1.000	1.000	1.000	1.000	1.000
89	1.000	1.000	1.000	1.000	1.000	1.000	0.991
88	1.000	1.000	1.000	1.000	1.000	1.000	0.983
87	1.000	1.000	1.000	1.000	1.000	1.000	0.974
86	1.000	1.000	1.000	1.000	1.000	1.000	0.965
85	1.000	1.000	1.000	1.000	1.000	1.000	0.956
84	0.997	0.997	0.997	0.997	0.992	1.000	0.948
83	0.994	0.994	0.994	0.994	0.984	1.000	0.939
82	0.992	0.992	0.992	0.992	0.976	1.000	0.930
81	0.989	0.989	0.989	0.989	0.968	1.000	0.921
80	0.986	0.986	0.986	0.986	0.960	1.000	0.913
79	0.983	0.983	0.983	0.983	0.952	0.999	0.904
78	0.980	0.980	0.980	0.980	0.944	0.998	0.895
77	0.977	0.977	0.977	0.977	0.936	0.995	0.886
76	0.974	0.974	0.974	0.974	0.928	0.991	0.878
75	0.972	0.972	0.972	0.972	0.920	0.986	0.869
74	0.969	0.969	0.969	0.969	0.912	0.980	0.860

Continued on Next Page

TABLE 5
Payment Factors Based on Per Cent Within Limits

PWL	Designated Large Sieve	4.75 mm Sieve	600 µm Sieve	75 µm Sieve	AC Content	Air Voids (Note 1)	Compaction (Note 2)
Continued From Previous Page							
73	0.966	0.966	0.966	0.966	0.904	0.973	0.851
72	0.963	0.963	0.963	0.963	0.896	0.964	0.843
71	0.960	0.960	0.960	0.960	0.888	0.955	0.834
70	0.957	0.957	0.957	0.957	0.880	0.944	0.825
69	0.954	0.954	0.954	0.954	0.872	0.933	0.816
68	0.951	0.951	0.951	0.951	0.864	0.920	0.808
67	0.949	0.949	0.949	0.949	0.856	0.906	0.799
66	0.946	0.946	0.946	0.946	0.848	0.891	0.790
65	0.943	0.943	0.943	0.943	0.840	0.875	0.781
64	0.940	0.940	0.940	0.940	0.832	0.858	0.773
63	0.937	0.937	0.937	0.937	0.824	0.839	0.764
62	0.934	0.934	0.934	0.934	0.816	0.820	0.755
61	0.931	0.931	0.931	0.931	0.808	0.799	0.746
60	0.929	0.929	0.929	0.929	0.800	0.778	0.738
59	0.926	0.926	0.926	0.926	0.790	0.755	0.729
58	0.923	0.923	0.923	0.923	0.780	0.731	0.720
57	0.920	0.920	0.920	0.920	0.770	0.706	0.711
56	0.917	0.917	0.917	0.917	0.760	0.680	0.703
55	0.914	0.914	0.914	0.914	0.750	0.653	0.694
54	0.911	0.911	0.911	0.911	0.740	0.624	0.685
53	0.909	0.909	0.909	0.909	0.730	0.595	0.676
52	0.906	0.906	0.906	0.906	0.720	0.564	0.668
51	0.903	0.903	0.903	0.903	0.710	0.533	0.659
50	0.900	0.900	0.900	0.900	0.700	0.500	0.650
49	0.882	0.882	0.882	0.882	0.686	0.490	0.637
48	0.864	0.864	0.864	0.864	0.672	0.480	0.624
47	0.846	0.846	0.846	0.846	0.658	0.470	0.611
Continued on Next Page							

TABLE 5
Payment Factors Based on Per Cent Within Limits

PWL	Designated Large Sieve	4.75 mm Sieve	600 µm Sieve	75 µm Sieve	AC Content	Air Voids (Note 1)	Compaction (Note 2)
Continued From Previous Page							
46	0.828	0.828	0.828	0.828	0.644	0.460	0.598
45	0.810	0.810	0.810	0.810	0.630	0.450	0.585
44	0.792	0.792	0.792	0.792	0.616	0.440	0.572
43	0.774	0.774	0.774	0.774	0.602	0.430	0.559
42	0.756	0.756	0.756	0.756	0.588	0.420	0.546
41	0.738	0.738	0.738	0.738	0.574	0.410	0.533
40	0.720	0.720	0.720	0.720	0.560	0.400	0.520
39	0.702	0.702	0.702	0.702	0.546	0.390	0.507
38	0.684	0.684	0.684	0.684	0.532	0.380	0.494
37	0.666	0.666	0.666	0.666	0.518	0.370	0.481
36	0.648	0.648	0.648	0.648	0.504	0.360	0.468
35	0.630	0.630	0.630	0.630	0.490	0.350	0.455
34	0.612	0.612	0.612	0.612	0.476	0.340	0.442
33	0.594	0.594	0.594	0.594	0.462	0.330	0.429
32	0.576	0.576	0.576	0.576	0.448	0.320	0.416
31	0.558	0.558	0.558	0.558	0.434	0.310	0.403
30	0.540	0.540	0.540	0.540	0.420	0.300	0.390
29	0.522	0.522	0.522	0.522	0.406	0.290	0.377
28	0.504	0.504	0.504	0.504	0.392	0.280	0.364
27	0.486	0.486	0.486	0.486	0.378	0.270	0.351
26	0.468	0.468	0.468	0.468	0.364	0.260	0.338
25	0.450	0.450	0.450	0.450	0.350	0.250	0.325
24	0.432	0.432	0.432	0.432	0.336	0.240	0.312
23	0.414	0.414	0.414	0.414	0.322	0.230	0.299
22	0.396	0.396	0.396	0.396	0.308	0.220	0.286
21	0.378	0.378	0.378	0.378	0.294	0.210	0.273
20	0.360	0.360	0.360	0.360	0.280	0.200	0.260
Continued on Next Page							

TABLE 5
Payment Factors Based on Per Cent Within Limits

PWL	Designated Large Sieve	4.75 mm Sieve	600 µm Sieve	75 µm Sieve	AC Content	Air Voids (Note 1)	Compaction (Note 2)
Continued From Previous Page							
19	0.342	0.342	0.342	0.342	0.266	0.190	0.247
18	0.324	0.324	0.324	0.324	0.252	0.180	0.234
17	0.306	0.306	0.306	0.306	0.238	0.170	0.221
16	0.288	0.288	0.288	0.288	0.224	0.160	0.208
15	0.270	0.270	0.270	0.270	0.210	0.150	0.195
14	0.252	0.252	0.252	0.252	0.196	0.140	0.182
13	0.234	0.234	0.234	0.234	0.182	0.130	0.169
12	0.216	0.216	0.216	0.216	0.168	0.120	0.156
11	0.198	0.198	0.198	0.198	0.154	0.110	0.143
10	0.180	0.180	0.180	0.180	0.140	0.100	0.130
9	0.162	0.162	0.162	0.162	0.126	0.090	0.117
8	0.144	0.144	0.144	0.144	0.112	0.080	0.104
7	0.126	0.126	0.126	0.126	0.098	0.070	0.091
6	0.108	0.108	0.108	0.108	0.084	0.060	0.078
5	0.090	0.090	0.090	0.090	0.070	0.050	0.065
4	0.072	0.072	0.072	0.072	0.056	0.040	0.052
3	0.054	0.054	0.054	0.054	0.042	0.030	0.039
2	0.036	0.036	0.036	0.036	0.028	0.020	0.026
1	0.018	0.018	0.018	0.018	0.014	0.010	0.013
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Notes: 1. For SMA, the payment factor for air voids as determined by this table shall not be used in the PF_{MC} . 2. Superpave 12.5FC 2 compaction shall be analysed using a lower limit (LL) of 90.5%. If the PWL for Superpave 12.5FC 2 compaction using a LL of 90.5% is greater than 95, the compaction PWL shall also be calculated using a LL of 91.5%, and the payment factor shall be determined for each LL using Table 7. The highest calculated payment factor shall be used.							

TABLE 6
Specification Limits For Hot Mix Asphalt Acceptance Attributes

Attributes	HMA Type	Lower Limit (LL) %	Upper Limit (UL) %
Asphalt Cement Content	All HMA types	JMF - 0.40 (Note 1)	JMF + 0.50
Designated Large Sieve	All HMA types	JMF - 5.0	JMF + 5.0
4.75 mm Sieve	All HMA types	JMF - 5.0	JMF + 5.0
600 µm Sieve	All HMA types	JMF - 3.5	JMF + 3.5
75 µm Sieve	All HMA types	JMF - 2.0	JMF + 2.0
Air Void Mix Design Criteria 4.0%	Superpave Mixes, SMA	2.5	5.5
Pavement Compaction	Superpave 12.5 and 12.5FC 1	91.5	97.0
	Superpave 37.5, 25.0 and 19.0	90.5	97.0
	Superpave 12.5FC 2	91.5 (Note 2)	98.0
	SMA 19.0, 12.5 and 9.5	93.0	98.0
Notes: 1. When a JMF change results in a decrease in the design asphalt cement content, the lower limit (LL) shall be set at the revised JMF minus 0.3% for all lots to which the JMF change applies. 2. Superpave 12.5FC 2 compaction shall be analysed using a LL of 90.5%. If the PWL for Superpave 12.5FC 2 compaction using a LL of 90.5% is greater than 95, the compaction PWL shall also be calculated using a LL of 91.5%, and the payment factor shall be determined for each LL using Table 7. The highest calculated payment factor shall be used.			

TABLE 7
Superpave 12.5FC 2 Pay Factors For Per Cent Within Limits > 95%

PWL	LL = 90.5%	LL = 91.5%
100	1.015	1.030
99	1.012	1.024
98	1.009	1.018
97	1.006	1.012
96	1.003	1.006

TABLE 8
Referee Testing Categories

Referee Categories	Conditions for Referee Testing
AC content and gradation with or without air voids and VMA, with or without compaction	May be carried out on any mix. If air voids referee testing is not to be included, its PF shall be at least 1.00 and the mean VMA shall not be less than design minimum. If air voids are to be included, VMA shall also be tested.
Air Voids and VMA only, with or without compaction	May only be carried out on Superpave mixes and provided that the PF for AC, the 4.75 mm, 600 µm, and 75 µm sieves are each at least 1.000.
Compaction Only	None

TABLE 9
Reference Densities, D_R

Region	Reference Densities, D_R tonnes/m³
Southwestern Region	2.530
Central Region Northeastern Region Northwestern Region	2.520
Eastern Region	2.390

TABLE 10
Referee Testing Rates

Testing	Cost
Determination of asphalt cement content, and aggregate gradation	\$250 per subplot sample
Determination of percent G_{mm} at N_{des} , including N_{ini}	\$250 per subplot sample
Determination of percent compaction	\$125 per subplot sample
Determination of draindown only	\$150 per subplot sample
Determination of correction factor for use of ignition furnace	\$1,000 per calibration
Determination of bulk relative density of both coarse and fine aggregate containing no RAP or RST aggregates	\$650
Determination of bulk relative density of both coarse and fine aggregate that incorporate extracted RAP and/or RST aggregates	\$950 (Note 1)
Determination of VMA	Sum of the rates of all additional tests required for its calculation
Note:	
1. This rate includes the extraction of the RAP or RST or both.	

Appendix 313-A, Commentary for OPSS.PROV 313, April 2007

Note: This appendix does not form part of the standard specification. It is intended to provide information to the designer on the use of this specification in the Contract.

Designer Action/Considerations

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



**CONSTRUCTION SPECIFICATION FOR UNTREATED SUBBASE,
BASE, SURFACE, SHOULDER, SELECTED SUBGRADE,
AND STOCKPILING**

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314.08	QUALITY ASSURANCE
314.09	MEASUREMENT FOR PAYMENT
314.10	BASIS OF PAYMENT

APPENDICES

314-A	Commentary

314.01	SCOPE

This specification covers the requirements for the construction of Subbase, Base, roadway surface, Shoulder, and edge ramping for bituminous pavements, selected subgrade and stockpiling at specified sites.

314.01.01 Specification Significance and Use

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

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

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 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:

Selected Subgrade means a granular material meeting the requirements of Select Subgrade Material (SSM), as specified in OPSS 1010, which is used to replace unsuitable native soils or raise the existing grade or both, in order to meet the final subgrade grading requirements, specified in the Contract Documents.

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.

314.05 MATERIALS

314.05.01 Aggregates

Aggregates used for Base, Subbase and selected subgrade applications shall be according to OPSS 1010.

314.05.02 Water

Water shall be free of any contaminants that could adversely affect the environment or the placement and compaction of materials for Base, Subbase and selected subgrade applications.

314.06 EQUIPMENT

314.06.01 Water

Equipment used for applying water to granular materials in order to meet compaction requirements for Base, Subbase and selected subgrade applications shall be equipped with variable flow control to uniformly and completely wet the material without causing the material to be eroded away. The equipment operator shall also have the capability to monitor and change the flow while the equipment is moving.

314.07 CONSTRUCTION

314.07.01 Subbase, Base, Surface, and Selected Subgrade

All materials shall be kept free from clay and other types of deleterious material. Construction operations shall not disturb underlying work.

All materials shall be placed in uniform lifts without segregation.

Except as provided under the Modified Layer Compaction Method clause:

- a) Granular B, Type II shall be placed in accordance with the compaction methods specified in the Granular B, Type II clause such that the thickness of the compacted layer is not greater than 150 mm.
- b) All other materials shall be placed such that the thickness of the compacted layer is not greater than 150 mm.

In all cases, each lift shall be bladed to a smooth surface according to the required cross-section and maintained until placement of a subsequent lift, when applicable.

Prior to closing down operations for each Day, the Subbase material shall be bladed and compacted and, if necessary, covered with sufficient Base material to carry traffic.

The Base shall be maintained to the tolerances in grade and cross-section and to the specified density until Contract Completion or, if the Contract includes paving, until the Base surface is paved.

314.07.02 Winter Grading

Any areas where materials used for Subbase, Base, selected subgrade or other fill applications are being placed shall be free of ice and snow. Frozen material shall not be incorporated into the Work. Materials used for Subbase, Base, selected subgrade or other fill applications shall not be placed over frozen ground. However, one lift of material may be placed over frozen ground, as long as the final grading and compaction of that lift is done after the underlying material has thawed.

314.07.03 Edge Ramping of Bituminous Pavement

A ramp of the specified 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

Material used for shouldering shall be placed and compacted at locations and to the line, grade, and cross-section specified in the Contract Documents.

Prior to 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 material for shouldering operations shall not commence along any section of pavement, until at least 6 hours have elapsed from the time of completion of the final bituminous pavement course in that section. In addition, for pavement sections that are already open to traffic, all shouldering operations shall be completed within 24 hours of their commencement. In all cases where a pavement section is not yet open to traffic, the shouldering shall be completed prior to opening that pavement section to traffic.

b) Concrete Pavement and Concrete Base

Shouldering operations shall commence according to OPSS 350. Shouldering shall be completed prior to 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.

314.07.05 Compaction

314.07.05.01 General

Each lift of material shall be compacted as specified below prior to the placement of the next lift.

The rate of placing material shall be controlled by the adequacy of the compaction obtained.

314.07.05.02 Compaction Requirements

314.07.05.02.01 Granular B, Type II

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.

314.07.05.02.02 All Other Granular Materials

The compaction requirements shall be according to OPSS 501.

314.07.05.03**Modified Layer Compaction Method**

Material may be placed in layers thicker than permitted under the Subbase, Base, Surface, and selected subgrade subsection, subject to the following provisions:

- a) All materials, with the exception of Granular B, Type II shall be placed in uniform layers such that each layer shall have a depth of not more than 300 mm after compaction.
- b) Granular B, Type II shall be placed in uniform layers with a compacted depth not to exceed the values shown in Table 1 for various sizes of single drum, vibratory, smooth wheel drum rollers. Both the minimum operating mass and the minimum operating dynamic force requirements shown in Table 1 shall be met for the roller used. 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.
- c) Prior to placing material in layers as described in a) or b) above depending on the type of granular material used, the ability of the proposed method to achieve satisfactory compaction shall be demonstrated to the satisfaction of the Contract Administrator by means of a two-lane trial area. The trial area location shall be approved by the Contract Administrator. At least 48 hours prior to any work commencing 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 submitted 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. Approval will follow within one Business Day after satisfactory completion of the compaction trial area.
- d) When the Contract Administrator, 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 it be 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, approval to change the system shall be obtained 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 required degree of compaction, changes shall be made as necessary to satisfy the requirements of this specification.

314.07.06**Tolerances**

The surface of the uppermost layer of granular material and each granular course shall be bladed, shaped, and compacted to produce the grade and cross-section specified in the Contract Documents, within the tolerances shown in Table 2.

In the event of a conflict between meeting horizontal grading tolerances and meeting vertical grading tolerances, the vertical grading tolerances shall take precedence.

314.07.07**Stockpiling of Granular Material**

Sites for stockpile construction, specified in the Contract Documents, shall be cleared and grubbed, regardless of stockpile height, according to OPSS 201. Organic soil underlying the stockpile location shall be removed and the site cleaned up prior to stockpile construction. Stockpiles shall be constructed, including the supply and placement of a pad upon which the materials are to be stockpiled, according to OPSS 1001.

314.07.08 Grade Checks

The Contract Administrator shall be notified within 12 hours when each Subbase or Base course has been completed, including Shoulders, and prior to the next course being placed.

The Contractor shall be responsible for carrying out all grade checks to ensure that horizontal and vertical grading tolerances are met.

Grade checks shall be carried out on all finished granular surfaces. Grade checks of granular grading surfaces shall be based on horizontal and vertical grading tolerances, as specified in the Tolerances subsection. The grade shall be certified at the stations and offsets shown in the grading templates, or when grading templates are not available, at the frequency requirements shown for the layout specified elsewhere in the Contract Documents.

314.07.09 Submission of Grade Checks

All grade checks concerning 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.

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 template is not available, then the Contractor shall complete, sign, and submit MTO form PH-CC-820 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 Owner may conduct random QA grade checks to verify that the grade and cross-section are within the specified tolerances.

314.08.02 Acceptance

If the Contract Administrator chooses not to take QA grade checks or if the QA grade checks conform to those determined by the Contractor, the work shall then be accepted.

However, if any discrepancies between the QA and the Contractor's grade checks are found, then, at the discretion of the Owner, additional QA grade checks may be carried out in any other location.

If the finished grade or cross-section or both are not within the tolerances specified in the Tolerances subsection, then:

- a) The Contract Administrator shall notify the Contractor and advise where the tolerances have not been met, including overbuilding of the width of a granular course.
- b) The Contractor shall be charged for each station where the tolerances have not been met, at the rate specified in the Basis of Payment section.
- c) The Contractor shall bring the granular surface to within the specified tolerances for grade, at no additional cost to the Owner.

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 and O
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, Compacted**

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 that have been 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 used as determined by the Contract Administrator:

a) End Area Method

i. At Source

The volume of material shall be measured at the source in its 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 or any other areas acceptable to the Owner, shall be deducted.

ii. In Place

When the measurement for payment of material in its original location is impractical, 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

The truck box method shall only be used when the Contract Administrator deems that the quantities are too small or the end area method is impractical for other reasons.

In this case, measurement for payment shall be based on the total volume in cubic metres of loose granular material, calculated by the Contract Administrator, from estimated percentages of the pre-determined capacity of each truck box determined from measurements of its dimensions.

Each truck that the Contractor intends to use shall be uniquely and readily identifiable to the satisfaction of the Contract Administrator.

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
- 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.

As specified in the Acceptance subsection, \$250.00 shall be deducted from payment for each station where the QA grade check of the finished grade is found to be outside of the specification limit.

Any additional grading carried out to correct grades that are not within the tolerances specified in the Tolerances subsection shall be carried out at no additional cost to the Owner.

Where a finished granular course exceeds the horizontal tolerances specified in the Tolerances subsection and the material outside that tolerance has been left in place, the Owner shall deduct from payment the theoretical quantity of material placed outside of that tolerance, based on a conversion factor of 2.0 t/m³, regardless of the type of granular material used.

TABLE 1
Modified Layer Compaction Thickness for Granular B, Type II
Single Drum, Vibratory, Smooth Wheel Drum Roller

Minimum Operating Mass kg	Minimum Operating Dynamic Force kN	Maximum Layer Depth After Compaction mm
5,000	75	300
8,000	150	450
12,000	250	600
15,000	350	750

TABLE 2
Allowable Tolerances for Finished Granular Surfaces

Tolerances From Specified Grade and Cross - Section	Finished Granular Courses mm	Finished Granular Surfaces Immediately Beneath Bituminous Courses, Sidewalks, and Curb and Gutter mm		Finished Granular Surfaces Immediately Beneath Concrete Courses, Sidewalks, and Curb and Gutter mm
		When the Finished Grade is Controlled by Fixed Components Such as Existing Pavements and Curbs	All Others	
Vertical	+ 30 - 30	+ 10 - 10	+ 30 - 30	+ 10 - 10
Horizontal	+ 30 - 0	+ 10 - 0	+ 30 - 0	+ 10 - 0
Surface Deviation (Note 1)	15	10		10
Notes:				
1. The maximum gap between a granular surface and the underside of a 3 m rigid metal straightedge, placed anywhere and in any direction on that surface.				

**Appendix 314-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

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



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 provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

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 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.

This specification refers to the following standards, specifications, and 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	Percent 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

C 174/C 174M-06 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.

Design Lift Thickness means the thickness in millimetres of the OGDL lift as specified in the Contract Documents.

Drainage System means the OGDL, subdrains, and the lateral outlets.

Duplicate Samples means two samples taken at the same time and location - one to be used for quality assurance testing and the other for referee testing.

Mixture, Mix means open graded drainage layer material treated with either asphalt cement or Portland cement.

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.

320.04 DESIGN AND SUBMISSION REQUIREMENTS

320.04.01 Submission Requirements

The following information shall be submitted to the Contract Administrator at least 3 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 be of sufficient accuracy and duration to 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 0.25 to 0.40, 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 percentage by mass of asphalt cement in the mixture shall be $1.8 \pm 0.2\%$.

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 $120 \pm 10 \text{ kg/m}^3$ 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 Curing of Portland Cement Treated OGDL

Portland cement treated OGDL mixture shall be cured using moisture vapour barrier. The moisture vapour barrier shall be a white opaque polyethylene film according to ASTM C 171, at least 100 µm thick.

The moisture vapour barrier shall be placed on the surface of OGDL immediately after compaction of the OGDL and within 2 to 4 metres of the compacting operation. Air flow in the space between the moisture vapour barrier and OGDL 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 OGDL. Curing shall continue for a minimum of 48 hours and until the OGDL has gained sufficient strength to support the paving equipment.

320.07.03 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.

320.07.04 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.

320.07.05 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.

320.07.06 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.

320.07.07 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 provided by the Contractor, 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.

The Contractor shall obtain at least one duplicate 25 kg sample of aggregate from every lot of 100,000 m² or part thereof of OGDL being produced.

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 m². In all cases, the subplot size shall not exceed 4,000 m².

Within 5 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 subplot at a random location selected by the Contract Administrator.

The Contractor shall supply suitable metal or cardboard containers that protect the integrity and shape of cores during transportation and until testing. The cores shall be taken in such a manner as to avoid sample damage. 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 of this specification.

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 Contractor shall be charged \$600.00 for each test initiated, which includes the cost of the testing using LS-614, administrative charges, and additional sampling, if required.

320.08.03.02 Thickness

One sample from each subplot shall be tested to determine the thickness of the OGDL according to ASTM C 174/C 174M. The test results for each subplot shall be used to compute the lot mean calculated to one decimal place for thickness according to LS-100.

320.08.03.03 Porosity

One sample from each subplot shall be tested according to LS-627 to determine the porosity of the OGDL, calculated to three 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 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 m² 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 requirements listed above and are not price adjusted, then all of the aggregates within that lot shall be considered rejectable 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 m².
- b) The combined area of multiple irregularities exceeds 10 m² over a 100 m² section.
- c) Any OGDL identified by the Contract Administrator as being contaminated.

OGDL that is rejected for its appearance shall be repaired. OGD L that is repaired shall be re-decisioned according to the Repairing and Re-D ecisioning 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, repaired and re-decisioned according to the Repairing and Re-D ecisioning subsection.

320.08.04.04 Acceptance of Thickness

Thickness acceptance shall be based on the mean of the lot, provided that no single subplot is deemed rejectable. A subplot shall be rejectable, if the subplot thickness is less than 0.60 of the design lift thickness. Rejectable sublots shall not be included in the lot mean thickness calculation.

If the lot mean thickness is equal to or greater than 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 rejectable, if the lot mean thickness is less than 0.75 of the design lift thickness.

If the Contractor elects to repair the lot in lieu of a price reduction or if a rejectable lot requires repair, the lot shall be repaired and decisioned according to the Repairing and Re-D ecisioning subsection.

320.08.04.05 Acceptance of Porosity

The test results for each subplot shall be used to compute the lot mean for the porosity of OGD L, and the porosity is calculated to two decimal places according to LS-100. Acceptance for the porosity of OGD L shall be based on the lot mean for the porosity of OGD L, and the porosity of individual sublots.

A subplot shall be rejectable if the porosity of OGD L is less than 0.20 or greater than 0.50. Rejectable sublots shall not be included in the lot mean porosity calculation, and shall be repaired according to the Repairing and Re-D ecisioning subsection.

The lot shall be accepted if the lot mean porosity of OGD L is equal to or greater than 0.25, and equal to or less than 0.40, and with less than 30% of sublots with porosity outside the range of 0.25 to 0.40.

If the lot mean porosity of OGD L is equal to or greater than 0.25, and equal to or less than 0.40, and with more than 30% of sublots with porosity outside the range of 0.25 to 0.40, those sublots outside the range shall require repair until more than 30% of sublots are within the range of 0.25 to 0.40 for the porosity.

The lot shall be rejectable if the lot mean porosity of OGD L is less than 0.20 or greater than 0.50, and shall be repaired according to the Repairing and Re-D ecisioning subsection.

If the lot mean porosity of OGD L is equal to or greater than 0.20 and less than 0.25, or greater than 0.40 and equal to and less than 0.50, the lot shall be subject 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-D ecisioning subsection.

320.08.04.06 Referee Testing for Gradation and Physical Properties

The Contractor may invoke referee testing for one or more attributes by submitting a written request to the Contract Administrator, within 5 Business Days following notification that a sample representing a lot of OGD L does not meet the requirements of this specification.

Referee testing shall be carried out, as specified herein and elsewhere 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, then the Contractor shall be responsible for the cost of the referee testing of that lot, including the cost of transporting the samples to the referee laboratory, at the rates specified elsewhere in the Contract Documents. 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

The Contractor may invoke re-testing for thickness and porosity by submitting a written request to the Contract Administrator, within 5 Business Days following notification that a sample representing a lot of OGDL does not meet the requirements of this specification.

The re-test shall be carried out on the same QA sample, as specified herein and elsewhere in the Contract Documents.

The Contractor may be present to witness the re-test of the same QA samples for thickness and porosity.

All re-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 re-test results, then the Contractor shall be responsible for the cost of the re-testing of that lot. 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 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 rejectable aggregates, as specified in the Acceptance of Gradation and Physical Properties clause, shall be removed and replaced.

320.08.05.03 Surface Appearance

Rejectable 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 subplot that is rejectable due to thickness or porosity or both, the entire subplot of OGDL shall be removed and replaced.

When repairs are made to rejectable sublots or those sublots that the Contractor elects to repair due to non-conformance, the lot shall be re-evaluated and re-decided for payment reduction. The original lot shall be divided into two reconfigured lots in the following way: All acceptable sublots shall be grouped as one lot and shall receive the full Contract price. The remaining sublots shall be grouped as another lot and shall use the retest results of the repaired sublots to calculate the mean lot, and shall be accepted either at the full Contract price, or 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 and the lot is not repaired, 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 the requirements for gradation and physical properties shall also be subject to a 10% payment reduction, as specified in the Acceptance Based on Gradation and Physical Properties clause.

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)

Percentage Passing By Mass of Aggregate (Note 1)		
Sieve Designation	Acceptance Limit	Price Reduction Range(s)
37.5 mm	100	90.1 – 100
26.5 mm	95 – 100	85.5 – 94.9
19.0 mm	90 – 100	81 – 89.9
16.0 mm	65 – 100	58.5 – 64.9
13.2 mm	40 – 86	36 – 39.9 or 86.1 – 94.6
9.5 mm	20 – 55	18 – 19.9 or 55.1 – 60.5
4.75 mm	0 – 10	10.1 – 12
2.36 mm	0 – 5	5.1 – 6
75 µm	0 – 2	2.1 – 2.4
Notes: 1. The grading of OGD L may not necessarily meet all of the limits shown in this table, as long as all other requirements specified herein and elsewhere in this Contract have been met. 2. All results are rounded to one decimal place.		

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	20.1 - 22.0
LS-614	Unconfined Freeze-Thaw, % maximum loss (Note 1)	15	15.1 - 18.8
LS-618	Micro-Deval Abrasion, % maximum loss	21	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)	≤2.0
Alternative Requirement for LS-614			
LS-606	Magnesium Sulphate Soundness, % maximum loss (Note 1)	15	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 and/or gypsum and/or gypsum wall board or plaster, etc. shall not exceed the maximum percentages by mass shown above. 3. All results are rounded to one decimal place.			

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 of the lot sample perpendicular height thickness in millimetres calculated to one decimal place according to LS-100.

PF_T is the payment factor for thickness 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 0.25 to 0.4	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	$1 - 2(n_c - 0.4)$

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, April 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

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



**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 provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

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 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.

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 passes the 26.5 mm sieve and not more than 75% passes the 4.75 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.

Surfaces of processed material that have been exposed to traffic and are to receive granular base material to depths of up to 100 mm as required in the Contract shall be scarified immediately prior to placement of the base course material.

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.

Payment for granular base shall be made under the appropriate roadway granular item.

For the purposes of the Changes in the Work clause of the MTO General Conditions of Contract, the depths of pavement to be processed shown in the Contract Documents shall be deemed to be incorrect only when the average depth of all processing differs by more than 15 mm from the equivalent average depth derived from measurements taken by the Contract Administrator during the processing operation.

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

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR FULL DEPTH RECLAMATION WITH EXPANDED ASPHALT STABILIZATION

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331.09	MEASUREMENT FOR PAYMENT
331.10	BASIS OF PAYMENT

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; if required, adding and blending corrective aggregates or active filler or both; 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 provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

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 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.

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

Ontario Provincial Standard Specifications, Construction

OPSS 301	Restoring Unpaved Roadway Surfaces
OPSS 313	Hot Mix Asphalt - End Result
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

Ministry of Transportation Publications

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-297	Determination of Indirect Tensile Strength of Expanded Asphalt Mixes
LS-602	Sieve Analysis of Aggregates
LS-625	Sampling of Granular Materials
SP-027	Manual for Assessment of Surface Defects of In-Place Recycled Pavement Mats

American Association of State Highway and Transportation Officials (AASHTO)

T40-02 Sampling Bituminous Materials

Wirtgen GmbH Publication

Wirtgen Cold Recycling Technology manual, 1st edition, 2012

331.03 DEFINITIONS

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

Active Filler means substances that chemically alter the mix properties.

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.

Expanded Asphalt Mix (EAM) Mat means a pavement course which comprises Expanded Asphalt Mix.

Hot Mix Asphalt (HMA) means as defined in OPSS 313

Performance Graded Asphalt Cement (PGAC) means as defined in OPSS 313.

Quality Assurance (QA) means as defined in OPSS 313.

Reclaimed Asphalt Pavement (RAP) means as defined in OPSS 313.

Reclaimed Material means the mixture of reclaimed existing asphalt pavement and granular base.

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 and to establish the necessity for corrective aggregate and/or active filler. The dry tensile strength shall be a minimum of 225 kPa and the wet tensile strength shall be a minimum of 100 kPa.

For bidding purpose only, the design rate of the expanded asphalt shall be as specified in the Contract Documents.

The mix design shall be carried out according to the Wirtgen Cold Recycling Technology manual using briquettes produced according to LS-297. The mix design shall be completed by a laboratory with Canadian Council of Independent Laboratories (CCIL) Type A certification or equivalent equipped to carry out expanded asphalt mix designs. 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 mix, referred to as the design rate, and all calculations performed to determine the design rate of 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 effects 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

A copy of the mix design shall be submitted to the Contract Administrator a minimum of 7 Business Days prior to the start of EAM operations. Within 4 Business Days after receiving the mix design, the Contract Administrator shall provide written confirmation of receipt of the submitted mix design documents or of any non-conformance to the contract requirements.

Confirmation of receipt of the mix design documents does not constitute any guarantee that the mix can be produced or constructed or both to Contract requirements, and does not relieve the Contractor of the responsibility for ensuring the specified quality of Materials and workmanship.

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 of the existing pavement changes significantly. Where more than one mix design is required, the area for which each mix design is to be used shall be clearly identified.

331.05 MATERIALS

331.05.01 Performance Graded Asphalt Cement

PGAC shall be according to OPSS 1101. The Additional Testing Requirements and Acceptance Criteria for PG Grades table shall not apply. PGAC shall be selected with performance properties meeting the design maximum pavement temperature of 52 °C and the minimum pavement temperature of -28 °C at a minimum, and the selected PGAC shall have suitable expansion characteristics.

331.05.02 Corrective Aggregates

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 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. Not more than 1% by mass of Portland cement shall be added to the mix.

331.05.04 Water

Water shall be clean and free from oil, acid, alkali, organic matter or other deleterious substances.

331.05.05 Expanded Asphalt Mix

The EAM shall be 100% passing the 37.5 mm sieve, and 95% to 100% passing the 26.5 mm sieve, and shall be measured based on air dried gradation according to coarse sieving operation of LS-602.

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 percent expanded asphalt, rate of application, and percent 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.

331.06.02 Placing Equipment

A mechanical paver capable of spreading the mix evenly in front of the screed in one continuous pass to the specified cross-fall and grade shall be used to place the EAM. 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 used to control traffic shall be according to 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 HMA course(s) 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 3 Days.
- b) It has been 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, 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 another Contract within the last 12 months.

The trial section shall be a minimum of 3,500 m² 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. A minimum of 48 hours notice shall be given to the Contract Administrator 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 the Surface Appearance subsection.

The Contractor shall be responsible for the repair, removal, or replacement of an unacceptable trial section according to the Repairing and Re-Evaluating subsection.

331.07.04 Expanded Asphalt Stabilization

Expanded asphalt stabilization shall be 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 Compacting the Expanded Asphalt Mix

The surface of the EAM shall be uniform in texture and free of surface defects.

Granular material shall be compacted according to OPSS 501.

The compacted surface of the EAM shall be according to the surface tolerances as specified in this specification.

331.07.06 Traffic Control with Moving Vehicles

Traffic shall be controlled with moving vehicles according to OTM, Book 7.

The moving vehicles shall guide one-way traffic through or around construction. The maximum speed of the moving vehicles shall be 30 km/h. Traffic control with moving vehicles shall be maintained until such time as the expanded asphalt stabilization is able to carry traffic without damage.

331.08 QUALITY ASSURANCE

331.08.01 General

Acceptance of the EAM shall be based on the following criteria:

- a) Surface Appearance
- b) Asphalt Cement Content
- c) Tensile Strength of EAM
- d) Thickness

- e) Surface Tolerance
- f) Compaction
- g) EAM Gradation
- h) Corrective Aggregates, if required.

Work that does not meet the acceptance criteria shall be repaired according to the Repairing and Re-Evaluating subsection.

331.08.02 Sampling

331.08.02.01 Lot Size

A lot size shall be a maximum of 50,000 m² of expanded asphalt stabilization divided into 10 sublots of equal size. The lot size may be adjusted at the discretion of the Contract Administrator and after discussion with the Contractor, prior to starting the work and when changes occur in the mix design or in the sequence of expanded asphalt stabilization. The maximum subplot size shall be 5,000 m². The minimum number of sublots in a lot shall be three.

331.08.02.02 Performance Graded Asphalt Cement

Samples of PGAC to be used in the mix shall be taken from the storage tank at the terminal according to the Tank Tap Method specified in AASHTO T40-02 and the terminal's health and safety plan in the presence of the Contract Administration at a frequency of three sets of samples per Contract for PGAC providing to three different lots. Each set of samples shall be a minimum of 2 full one-litre portions. The Contractor's health and safety plan and procedure for sampling shall be reviewed at the pre-pave meeting.

Sample containers supplied by the Contractor shall be triple tight steel containers or suitable containers that can be sealed to prevent leakage or contamination.

331.08.02.03 Corrective Aggregate

Where the quantity of corrective aggregate is greater than 5,000 tonnes, two 25 kg samples shall be taken in the presence of the Contract Administrator for each 25,000 tonnes of material produced, and whenever material is produced from a new source or new bench in a quarry, or whenever a significant change in production of materials occurs.

QA samples shall be taken in accordance with procedures given in LS-625 and at the time and location determined by the Contract Administrator.

331.08.02.05 Expanded Asphalt Mix

For the purpose of accepting the asphalt cement content, samples of unstabilized material and EAM shall be taken at a minimum frequency of one set of samples per subplot. To obtain a set of samples, one 15 kg sample of unstabilized material shall be obtained 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.

For the purpose of determining the EAM gradation, another 30 kg sample of EAM shall be taken from each of three randomly selected sublots for every lot.

The samples shall be packaged in non-absorptive materials to protect sample integrity and sealed in waterproof containers. The samples shall be transported in a manner that avoids stacking and extreme temperatures.

331.08.03 Acceptance Criteria

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

For each subplot, 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 according to LS-282. 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 a lot 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 and wet tensile strength according to LS-297.

Dry tensile strength requirements for the lot are met when the following are satisfied:

- a) The mean dry tensile strength of the lot is equal to or greater than 225 kPa; and
- b) No individual subplot dry tensile strength is less than 200 kPa.

Wet tensile strength requirements for the lot are met when the following are satisfied:

- a) The mean wet tensile strength of the lot is equal to or greater than 100 kPa; and
- b) No individual subplot wet tensile strength is less than 75 kPa.

EAM that does not meet the above dry tensile strength and wet tensile strength requirements shall be deemed rejectable.

331.08.03.04 Thickness

Thickness of the EAM shall be measured by the Contract Administrator at a minimum frequency of one thickness measurement per subplot. 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 the lot are met when the following are satisfied:

- a) At least 90% of all thickness measurements are equal to or greater than the specified thickness minus 20 mm, and

- b) No individual thickness measurement for the lot is less than the specified thickness minus 30 mm.

331.08.03.05 Surface Tolerance

The surface tolerance of any EAM surface shall be such that when tested with a 3 m straight edge placed anywhere on the EAM surface, including the edge of the EAM, in any direction on the surface, there shall not be a gap between the bottom of the straight edge and the surface of the EAM greater than 10 mm according to OPSS 301.

331.08.03.06 Compaction

Compaction measurements shall be taken by the Contract Administrator according to OPSS 501 for granular materials and at a minimum frequency of one QA measurement per subplot. Compaction requirements of the EAM placed for the lot are met when the following are satisfied:

- a) The lot average of all compaction measurements is greater than or equal to 97% of the target density; and
- b) No individual compaction measurement for the subplot is less than 95% of the target density.

331.08.03.07 Expanded Asphalt Mix Gradation

If the EAM does not meet the gradation requirements, the Contractor shall submit an action plan of mediation to the Contract Administrator for approval within 2 Business Days after the delivery of the QA testing results.

331.08.03.08 Corrective Aggregate

QA testing shall 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.

331.08.04 Repairing and Re-Evaluating

331.08.04.01 General

With the exception of repairs for surface tolerance, the minimum width of repair shall be the full lane width.

For repairs due to the surface appearance defects, the minimum repair length shall be sufficient for the repair to be carried out by the reclaimer-stabilizer equipment. For other repairs based on the lot and subplot acceptance, the minimum length shall be according to the Repairing and Re-Evaluating clause of OPSS 313. All repairs shall be made using the same equipment as was used during initial production and placement.

All repairs will be re-evaluated and retested according to Acceptance Criteria subsection.

331.08.04.02 Surface Appearance

Unacceptable EAM due to the surface appearance defects, including any area damaged or contaminated by traffic, by water added by Contractors during compaction, or by nature, shall be reprocessed by the reclaimer-stabilizer. If required, additional expanded asphalt shall be added during reprocessing.

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 313.

331.08.04.03 Asphalt Cement Content

For sublots with insufficient asphalt cement content, the EAM mat shall be reprocessed by the reclaimer-stabilizer with addition of asphalt cement during reprocessing. For sublots with excessive asphalt cement content, the EAM mat shall be reprocessed by the reclaimer-stabilizer with addition of corrective aggregates during reprocessing. The unacceptable sublots are repaired until the corresponding lot mean is within the acceptance tolerance.

331.08.04.04 Tensile Strength

The rejectable sublots shall be reprocessed by the reclaimer-stabilizer, if required, with addition of asphalt cement during reprocessing until the corresponding lot mean is above the acceptance criterion. Alternatively, the EAM mat shall be removed to a minimum depth of 50 mm and replaced by an appropriate HMA approved by the Contract Administrator.

331.08.04.05 Thickness

For sublots with insufficient thickness, the Contractor shall determine the limits of the unacceptance EAM based on additional measurement. The pavement segments with insufficient thickness shall be overlaid with binder course or surface course with additional thickness so as to compensate for the insufficient thickness as found in EAM layer.

331.08.04.06 Surface Tolerance

To meet the specified surface tolerance, 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.

331.08.04.07 Compaction

Mixes that cannot be compacted to the specified density shall be removed to a minimum depth of 50 mm and replaced by HMA approved by the Contract Administrator.

331.09 MEASUREMENT FOR PAYMENT

331.09.01 Actual Measurement

331.09.01.01 Full-Depth Reclamation with Expanded Asphalt Stabilization

Measurement of full-depth reclamation with expanded asphalt stabilization shall be 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 items shall be full compensation for all labour, Equipment, and Material to do the work.

The addition of corrective aggregate, active filler or other additives, including any expanded asphalt that is required due to the additives, shall be at no extra cost to the Owner.

HMA required to replace unacceptable EAM 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.

The additional expanded asphalt, if required, added during reprocessing 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 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

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR COLD IN-PLACE RECYCLING

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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 active filler if required, adding and mixing 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 provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

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 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.

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

Ontario Provincial Standard Specifications, Construction

OPSS 313 Hot Mix Asphalt - End Result

Ontario Provincial Standard Specifications, Material

OPSS 1103 Emulsified Asphalt
OPSS 1301 Cementing Materials

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

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

SP-027 Manual for Assessment of Surface Defects of In-Place Recycled Pavement Mats

ASTM International

D6752/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.

Cold In-Place Recycled (CIR) Mix means the in-place mixture of existing reclaimed HMA pavement, emulsified asphalt, and water.

Hot Mix Asphalt (HMA) means as defined in OPSS 313

Quality Assurance (QA) means as defined in OPSS 313.

Reclaimed Asphalt Pavement (RAP) means as defined in OPSS 313.

Target Density means the average bulk relative density for the lot established according to LS-300 by the QA testing laboratory, 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, 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 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 Canadian Council of Independent Laboratories (CCIL) Type A certification or equivalent equipped to carry out CIR mix design. Where 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 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 effects to the mix properties.
- f) Recovered penetration for the binder of the existing pavement according to LS 200.

g) Type, source and quantity of active filler, if required.

333.04.02 Submission Requirements

A copy of the mix design shall be submitted to the Contract Administrator a minimum of 7 Business Days prior to the start of CIR operations. Within 4 Business Days after receiving the mix design, the Contract Administrator shall provide written confirmation of receipt of the submitted mix design documents or of any non-conformance to the contract requirements.

Confirmation of receipt of the mix design documents does not constitute any guarantee that the mix can be produced or constructed or both to Contract requirements, and does not relieve the Contractor of the responsibility for ensuring the specified quality of Materials and workmanship.

A new mix design shall be submitted when the emulsified asphalt design rate is adjusted by greater than 0.20%. Separate or new mix designs shall be submitted if the composition or layer thicknesses of the existing pavement changes significantly. Where more than one mix design is required, the area for which each mix design is to be used shall be clearly identified.

333.05 MATERIALS

333.05.01 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, and shall be measured based on air dried gradation according to the coarse sieving operation of LS-602.

333.05.02 Emulsified Asphalt

Emulsified asphalt shall be polymer modified mixing grade according to OPSS 1103 and be compatible with the process and materials used.

333.05.03 Water

Water shall be clean and free from oil, acid, alkali, organic matter, or other deleterious substances.

333.05.04 Active Filler

When active filler is required, it shall be incorporated into the existing reclaimed asphalt pavement at the application rate specified in the mix design.

When used as active filler, Portland cement shall be according to OPSS 1301. Not more than 1% by mass of Portland cement shall be added to the mix.

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 screening and sizing unit capable of processing the RAP.

- 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 prior to the start of the work 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 capable of producing a uniform and thoroughly blended CIR mix.

333.06.02 Placing Equipment

A mechanical paver capable of spreading the mix evenly in front of the screed in one continuous pass to the specified crossfall and grade shall be used to place the CIR mix. 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

Compaction equipment shall be selected to achieve the required compaction.

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 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.

333.06.06 Pilot Vehicle

Pilot vehicles used to control traffic shall be according to OTM, Book 7.

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. Cold in-place recycled mix shall not be placed after September 1st without the written approval from the Contract Administrator. The work shall be carried out when the roadway is clean and free of standing water. The work shall not proceed during periods of rain or when the surface is in a saturated condition.

All traffic, including construction traffic, shall be kept off the freshly placed CIR mat until it is able to carry traffic without damage. Any damage to the 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 section.
- 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, 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 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 has been demonstrated 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. A minimum of 48 hours notice shall be given to the Contract Administrator 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, the trial section shall be repaired or removed and replaced until the CIR meets the requirements of the Surface Appearance subsection.

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, and longitudinal and transverse joints after reclaiming operations are completed and before placing CIR mix.

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 emulsified asphalt added shall not be less than 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 constructed to the crossfall and grade specified in the Contract Documents. The surface of the CIR mat shall be of uniform texture and free of segregation, raveling, rutting, longitudinal streaks, flushing, fat spots, oil spills, roller marks, and other defects.

333.07.08 Drying

Prior to the placement of the wearing surface, the Contractor may elect to use a drying unit. Overheating or burning of the CIR shall not be allowed.

333.07.09 Traffic Control with Moving Vehicles

Traffic shall be controlled with moving vehicles according to OTM, Book 7.

The moving vehicles shall guide one-way traffic through or around construction. The maximum speed of the moving vehicles shall be 30 km/h. Traffic control with moving vehicles shall be maintained until such time as the CIR mat is able to carry traffic without damage.

333.07.10 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

333.08 QUALITY ASSURANCE

333.08.01 General

Acceptance of the CIR mix shall be based on the following criteria:

- a) Surface Appearance
- b) Surface Tolerance
- c) Moisture Content
- d) Compaction
- e) RAP Gradation

Work that does not meet the acceptance criteria shall be repaired according to the Repairing and Re-Evaluating subsection.

333.08.02 Sampling

333.08.02.01 Lot Size

The Contract Administrator shall determine the size and location of the lots and sublots after discussion with the Contractor and before CIR production starts. A lot shall typically represent 25,000 m² with 5 equal sublots of 5,000 m² in size.

333.08.02.02 Cold In-Place Recycling Material

Samples of CIR material shall be packaged in non-absorptive materials to protect sample integrity and sealed in waterproof containers. Samples shall be transported in a manner that avoids stacking and extreme temperatures.

333.08.02.02.01 Slabs

At least 4 Business Days prior to the planned overlay of the CIR mat, 2 slab samples of the CIR material shall be obtained from each subplot. The two slab samples shall be located side-by-side and taken at random locations as directed by the Contract Administrator. Each slab sample shall be dry cut 150 mm x 150 mm and removed intact from the CIR mat.

One slab sample shall be used to test for bulk relative density and the other slab sample shall be used to test for moisture content. The result of the moisture content will be used for both the moisture acceptance, and moisture adjustment for compaction calculation according to LS-306.

Additional slab samples for QA acceptance tests shall only be taken after the Contractor has carried out remedial work to improve moisture content and/or compaction in the rejected subplot. The Contractor shall be charged the cost of additional tests.

333.08.02.02.02 Loose Mix Samples

For the purpose of determining the RAP gradation, 30 kg of loose CIR mix samples shall be taken from each of two randomly selected sublots for every lot.

333.08.02.03 Reclaimed Material

At the start of production of each new lot or whenever the existing pavement material significantly changes composition, one 15 kg sample of material reclaimed from the roadway shall be obtained prior to adding emulsion for the purpose of determining the target density for compaction. Samples shall be taken at random locations as directed by the Contract Administrator.

333.08.02.04 Emulsified Asphalt

Samples of emulsified asphalt used in the mix shall be taken at the job site from the tankers according to the Contractor's health and safety plan at a frequency of three sets of samples per Contract randomly taken from three different lots. 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. The Contractor's health and safety plan and procedure for sampling shall be reviewed at the pre-pave meeting.

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.

333.08.03 Acceptance Criteria

333.08.03.01 Surface Appearance

Surface appearance shall be assessed by the Contract Administrator based on visual surveys after the CIR mat has been opened to traffic. The finished CIR surface shall have a uniformly smooth texture and shall meet the surface appearance requirements of ravelling, segregation and rutting as specified in Table 1 prior to placement of HMA overlay.

333.08.03.02 Surface Tolerance

The surface tolerance of any CIR surface shall be such that when tested with a 3 m straight edge placed anywhere on the CIR surface, except across the crown, and in any direction on the surface, there shall not be a gap between the bottom of the straight edge and the surface of the CIR greater than 6 mm.

333.08.03.03 Moisture Content

The QA laboratory shall test one sample from each subplot to determine the moisture content of CIR mix according to LS-291, and the test result of the moisture content shall be rounded to one decimal place according to LS-100. The test result for each subplot shall be used to compute the lot mean for moisture content of CIR mix.

The moisture content of CIR mix acceptance shall be based on the mean moisture content of the lot and the moisture content of the individual sublots. The lot is acceptable if the lot mean moisture content is equal to or less than 2% with no individual subplot's moisture content greater than 3%. The lot is rejectable if the lot mean moisture content of CIR mix is greater than 3%. Any subplot with its moisture content greater than 3% shall be deemed rejectable.

If the lot mean moisture content of CIR mix is less than 3% and greater than 2%, the Contractor may elect to accept a payment reduction or repair for the lot. The payment reduction shall be calculated according to Table 2. If the Contractor elects to repair the lot in lieu of a payment reduction, the lot shall be repaired according to the Repairing and Re-Evaluating subsection.

333.08.03.04 Compaction

The compaction of the CIR mix shall be calculated for each subplot from the bulk relative density determined from slab samples according to LS-306 or ASTM D-6752, and the target density for the lot as follows:

$$\text{Compaction} = (\text{bulk relative density of slab sample} / \text{target density}) \times 100\%$$

where the target density to be used for acceptance purposes shall be calculated for each lot from material reclaimed from the roadway prior to adding emulsion. The target density shall be established according to LS-300.

Each lot of CIR mix shall be compacted to a minimum mean of 96.0% of the target density established for the mix, with no individual subplot's bulk relative density result falling below 95.0% of the target density. CIR that is not compacted to the required density shall be deemed rejectable.

333.08.03.05 Reclaimed Asphalt Pavement Gradation

If the RAP does not meet the gradation requirements, the Contractor shall submit an action plan of remediation to the Contract Administrator for approval within 2 Business Days after the delivery of the QA testing results.

333.08.04 Repairing and Re-Evaluating

CIR mix that is rejectable based on the Acceptance Criteria subsection shall be repaired according to the requirements specified in Table 1.

Repairs shall be for the full lane width. For repairs due to surface appearance defects, the minimum repair length shall be sufficient for the repair to be carried out by the recycling train, or by the paving equipment, whichever is applicable. For other repairs based on the lot and subplot acceptance, the minimum length shall be according to the Repairing and Re-Evaluating clause of OPSS 313 and to the depth specified in Table 1.

The HMA required to repair unacceptable CIR shall be placed in compacted lift thicknesses between 40 and 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.

All repairs will be re-evaluated and retested according to the Acceptance Criteria subsection.

When repairs are made to rejectable sublots or those sublots that the Contractor elects to repair due to the non-conformance of the moisture content requirements, the lot shall be re-evaluated and re-decisioned for payment reduction. The original lot shall be divided into two reconfigured lots in the following way: All acceptable sublots (with moisture content equal to or less than 2%) shall be grouped as one lot and shall receive the full Contract price. The remaining sublots shall be grouped as another lot and shall use the retest results of the repaired sublots to calculate the mean lot moisture content, and shall be accepted either at the full Contract price, or subjected to a payment reduction, or deemed rejectable.

333.09 MEASUREMENT FOR PAYMENT

333.09.01 Actual Measurement

333.09.01.01 Cold In-Place Recycled Mix

Measurement of CIR mix 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 active filler or other additives to the mix, including any emulsion that is required due to the additives, 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.

333.10.02**Payment Reduction for Moisture Content**

When test results show that the moisture content payment factor for the lot is less than 1.000 and the Contractor is not required to or does not elect to repair the lot, the payment reduction for the lot shall be as follows:

$(1.000 - \text{Payment Factor}) \times \text{item price} \times \text{lot quantity}$

For purposes of payment reduction, the term item price means the Contract price of the applicable tender item.

For purposes of re-decision after repairs, the lot quantity is the area of the reconfigured lot.

TABLE 1
Acceptance Criteria and Repair Requirements for CIR Mix

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 CIR 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 CIR 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.
Moisture Content	Non-conformance for moisture Content as per the Moisture Content subsection of the Acceptance Criteria.	> 3% for Moisture Content of Lot or Individual Sublot	Rejectable	For rejected sublots, or sublots within the corresponding rejected lot: 1) Use drying unit as specified in the Drying Unit subsection to dry the CIR mat, or 2) Reprocess with a recycling train (Note 2), or 3) Remove CIR material to full depth and replace with an acceptable binder course HMA.
Compaction	Non-conformance for compaction as per the Compaction subsection of the Acceptance Criteria.	< 96% for Compaction of Lot; and < 95% for Compaction of Individual Sublot	Rejectable	For rejected sublots, or sublots within the corresponding rejected lot: 1) Recompect the CIR mat, if required, with reheating process, or 2) Reprocess with a recycling train (Note 2), or 3) Remove CIR material to full depth and replace with an acceptable binder course HMA.
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.				

TABLE 2
Moisture Content of CIR Mix Payment Factors

Moisture Content Payment Factors Acceptance Criteria	Classification	Payment Factor, PFT
MC ≤ 2%	Acceptable	1.000
2% < MC ≤ 3%	Payment Reduction	$1 - \text{TODRF} \times (\text{MC} - 2)/10$
MC > 3%	Rejectable	N/A

Where:
MC = the mean of the lot sample of moisture content of CIR Mix in percent calculated to one decimal place according to LS-100.
PFT = the payment factor for moisture content calculated to three decimal places according to LS-100.
TODRF = Tender Opening Date Reduction Factor according to Table 3.

TABLE 3
Tender Opening Date Reduction Factor

Year of Tender Opening	Tender Opening Date Reduction Factor
2015	0.65
2016	0.8
2017	1.0

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

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR COLD IN-PLACE RECYCLING WITH EXPANDED ASPHALT

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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 active filler 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 provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

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 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.

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

Ontario Provincial Standard Specifications, Construction

OPSS 313 Hot Mix Asphalt - End Result

Ontario Provincial Standard Specifications, Material

OPSS 1101 Performance Graded Asphalt Cement
OPSS 1301 Cementing Materials

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-602 Sieve Analysis of Aggregates

Ontario Traffic Manual (OTM):

OTM Book 7 - Temporary Conditions

SP-027 Manual for Assessment of Surface Defects of In-Place Recycled Pavement Mats

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)

T40-02 Sampling Bituminous Materials

Wirtgen GmbH Publication

Wirtgen Cold Recycling Technology manual, 1st edition, 2012

335.03 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.

Cold In-Place Recycled Expanded Asphalt Mix (CIREAM) means the in-place mixture of existing reclaimed asphalt pavement (RAP), active filler, and expanded asphalt.

Cold In-Place Recycled Expanded Asphalt Mix (CIREAM) Mat means a pavement course which comprises Cold In-Place Recycled Expanded Asphalt Mix

Expanded Asphalt means heated asphalt cement expanded from its normal volume by the addition of water.

Hot Mix Asphalt (HMA) means as defined in OPSS 313.

Performance Graded Asphalt Cement (PGAC) means as defined in OPSS 313.

Quality Assurance (QA) means as defined in OPSS 313.

Reclaimed Asphalt Pavement (RAP) means as defined in OPSS 313.

Target Density means the average bulk relative density for each subplot established according to LS-297, and used to determine the per cent compaction.

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 that are 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 mix design shall meet the following requirements:

- a) The design rate of the expanded asphalt shall be a minimum of 1.0%.
- b) The dry tensile strength shall be a minimum of 225 kPa and the wet tensile strength shall be a minimum of 100 kPa.

The mix design shall be carried out according to the Wirtgen Cold Recycling Technology manual using briquettes produced according to LS-297. Mix design shall be completed by a laboratory with Canadian Council of Independent Laboratories (CCIL) Type A certification or equivalent equipped to carry out expanded asphalt mix designs. 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 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 effects to the mix properties.
- h) Recovered penetration for the binder of the existing pavement according to LS-200.
- i) Type, source and quantity of active filler, if required.

335.04.02 Submission Requirements

A copy of the mix design shall be submitted to the Contract Administrator a minimum of 7 Business Days prior to the start of CIREAM operations. Within 4 Business Days commencing after the day of delivery of all required documents for the mix design, the Contract Administrator shall provide written confirmation of receipt of the submitted mix design documents or of any non-conformance to the contract requirements.

Confirmation of receipt of the mix design documents does not constitute any guarantee that the mix can be produced or constructed or both to Contract requirements, and does not relieve the Contractor of the responsibility for ensuring the specified quality of Materials and workmanship.

A new mix design shall be submitted when the expanded asphalt design rate is adjusted by greater than 0.20%. Separate or new mix designs shall be submitted if the composition or layer thicknesses of the existing pavement changes significantly. Where more than one mix design is required, the area for which each mix design is to be used shall be clearly identified.

335.05 MATERIALS

335.05.01 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, and shall be measured based on air dried gradation according to the coarse sieving operation of LS-602.

335.05.02 Performance Graded Asphalt Cement

PGAC shall be according to OPSS 1101. The table of Additional Testing Requirements and Acceptance Criteria for PGAC Grades shall not apply. PGAC shall be selected with performance properties meeting the design maximum pavement temperature of 52 °C and the minimum pavement temperature of -28 °C at a minimum, and the selected PGAC shall have suitable expansion characteristics.

335.05.03 Water

Water shall be clean and free from oil, acid, alkali, organic matter, or other deleterious substances.

335.05.04 Active Filler

If required by the mix design, active filler shall be incorporated into the reclaimed existing asphalt pavement at the application rate determined in the mix design.

When used as active filler, Portland cement shall be according to OPSS 1301. Not more than 1% by mass of Portland cement shall be added to the mix.

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 screening and sizing unit capable of processing the RAP.
- 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 prior to the start of the work 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 capable of producing a uniform and thoroughly blended CIREAM.

335.06.02 Placing Equipment

A mechanical paver capable of spreading the mix evenly in front of the screed in one continuous pass to the specified crossfall and grade shall be used to place the CIREAM. 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

Compaction equipment shall be selected to achieve the required compaction.

335.06.04 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.

335.06.05 Pilot Vehicle

Pilot vehicles used to control traffic shall be according to OTM, Book 7.

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.

335.07.03 Operational Constraints

Cold in-place recycled expanded asphalt mix (CIREAM) shall not be placed after September 1st without the written approval from the Contract Administrator.

The work shall be carried out when the roadway is clean and free of standing water. Cold in-place recycled expanded asphalt mix shall not proceed during periods of rain or when the surface is in a saturated condition.

All traffic, including construction traffic, shall be kept off the freshly placed CIREAM mat until it is able to carry traffic without damage. Any damage to the CIREAM mat shall be repaired.

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 Recycling Expanded Asphalt Trial Section

Prior to carrying out CIREAM, the ability to successfully carry out CIREAM 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 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 has been demonstrated 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. A minimum of 48 hours notice shall be given to the Contract Administrator prior to placing the trial section.

The Contract Administrator shall allow the CIREAM work to continue 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 trial sections shall be repaired or removed and replaced until the CIREAM meets the requirements of the Surface Appearance subsection.

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, and 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 expanded asphalt added shall not be less than 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 constructed to the crossfall and grade specified in the Contract Documents. The surface of the CIREAM mat shall be of uniform texture and free of segregation, raveling, rutting, longitudinal streaks, flushing, fat spots, oil spills, roller marks, and other defects.

335.07.08 Traffic Control with Moving Vehicles

Traffic shall be controlled with moving vehicles according to OTM, Book 7.

The moving vehicles shall guide one-way traffic through or around construction. The maximum speed of the moving vehicles shall be 30 km/h. Traffic control with moving vehicles shall be maintained until such time as the CIREAM mat is able to carry traffic without damage.

335.07.09 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

335.08 QUALITY ASSURANCE

335.08.01 General

Acceptance of the CIREAM shall be based on the following criteria:

- a) Surface Appearance
- b) Surface Tolerance
- c) Compaction
- d) Tensile Strength
- e) RAP Gradation

Work that does not meet the acceptance criteria shall be repaired according to the Repairing and Re-Evaluating subsection.

335.08.02 Sampling

335.08.02.01 Lot Size

The Contract Administrator shall determine the size and location of the lots and sublots after discussion with the Contractor and before CIREAM production starts. A lot shall typically represent 25,000 m² with 5 equal sublots of 5,000 m² in size.

335.08.02.02 Cold In-Place Recycled Expanded Asphalt Mix Samples

Samples of CIREAM material shall be packaged in non-absorptive materials to protect sample integrity and sealed in waterproof containers. Samples shall be transported in a manner that avoids stacking and extreme temperatures.

335.08.02.02.01 Loose Samples

After placement and prior to compaction, the Contractor shall obtain one 15 kg sample of the CIREAM from each subplot, 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 and wet tensile strength according to LS-297.

For the purpose of determining the RAP gradation, another 30 kg sample of CIREAM samples shall be taken from each of two randomly selected sublots for every lot.

335.08.02.02.02 Slabs

Prior to the planned overlay of the CIREAM mat, two slab samples of the CIREAM material shall be obtained from each subplot. The two slab samples shall be located side-by-side and taken at random locations as directed by the Contract Administrator. Each slab samples shall be dry cut 150 x 150 mm and removed intact from the CIREAM mat.

One slab sample shall be used to test for bulk relative density and the other slab sample shall be used to test for moisture content for the purpose of moisture adjustment according to LS-306.

Additional slab samples for QA acceptance tests shall only be taken after the Contractor has carried out remedial work to improve compaction in the rejected subplot. The Contractor shall be charged the cost of additional tests.

335.08.02.03 Performance Graded Asphalt Cement

Samples of PGAC to be used in the mix shall be taken from the storage tank at the terminal according to the Tank Tap Method specified in AASHTO T40-02 and the terminal's health and safety plan in the presence of the Contract Administrator at a frequency of three sets of samples per Contract for PGAC providing to three different lots. Each set of samples shall be a minimum of 2 full one-litre portions. The Contractor's health and safety plan and procedure for sampling shall be reviewed at the pre-pave meeting.

Samples of PGAC used in the mix shall be obtained, properly labelled and identified, and delivered to the designated QA testing laboratory as specified in the Contract Documents.

335.08.03 Acceptance Criteria

335.08.03.01 Surface Appearance

Surface appearance shall be assessed by the Contract Administrator based on visual surveys after the CIREAM mat has been opened to traffic. The finished CIREAM surface shall have a uniformly smooth texture and shall meet the surface appearance requirements of ravelling, segregation and rutting as specified in Table 1 prior to placement of HMA overlay.

335.08.03.02 Surface Tolerance

The surface tolerance of any CIREAM surface shall be such that when tested with a 3 m straight edge placed anywhere on the CIREAM surface, except across the crown, and in any direction on the surface, there shall not be a gap between the bottom of the straight edge and the surface of the CIREAM greater than 6 mm.

335.08.03.03 Compaction

The compaction of the CIREAM mix shall be calculated for each subplot 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%

where the target density to be used for acceptance purposes shall be calculated for each subplot by averaging the densities of the six (6) compacted specimens produced for indirect tensile strength testing according to LS-297.

Each lot of CIREAM shall be compacted to a minimum mean of 96.0% of the target density established for the mix, with no individual subplot bulk relative density result falling below 95.0% of the target density. CIREAM that is not compacted to the required density shall be deemed rejectable.

335.08.03.04 Tensile Strength of Cold In-Place Recycled Expanded Asphalt Mix

Acceptance of the CIREAM shall be based on dry tensile strength and wet tensile strength.

Samples of CIREAM shall be tested for acceptance purposes according to LS-297.

Dry tensile strength requirements for the lot are met when:

- a) The mean dry tensile strength of the lot is equal to or greater than 225 kPa; and
- b) No individual subplot dry tensile strength is less than 200 kPa.

Wet tensile strength requirements for the lot are met when:

- a) The mean wet tensile strength of the lot is equal to or greater than 100 kPa; and
- b) No individual subplot wet tensile strength is less than 75 kPa.

CIREAM that does not meet the above dry tensile strength and wet tensile strength requirements shall be deemed rejectable.

335.08.03.05 Reclaimed Asphalt Pavement Gradation

If the RAP does not meet the gradation requirements, the Contractor shall submit an action plan of remediation to the Contract Administrator for approval within 2 Business Days after the delivery of the QA testing results.

335.08.04 Repairing and Re-Evaluating

CIREAM that is rejectable based on the Acceptance Criteria subsection shall be repaired according to the requirements specified in Table 1.

Repairs shall be for the full lane width. For repairs due to the surface appearance defects, the minimum repair length shall be sufficient for the repair to be carried out by the recycling train, or by the paving equipment, whichever is applicable. For other repairs based on the lot and subplot acceptance, the minimum length shall follow the Repairing and Re-Evaluating clause of OPSS 313 and to the depth specified in Table 1.

The HMA required to repair unacceptable CIREAM shall be placed in compacted lift thicknesses between 40 and 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.

All repairs will be re-evaluated and retested according to the Acceptance Criteria subsection.

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 active filler or other additives to the mix, including any expanded asphalt that is required due to the additives, 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 an unacceptable CIREAM 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 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 straightedge 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) Recompect 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, 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

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR THE GRINDING OF CENTRELINE AND SHOULDER RUMBLE STRIPS IN ASPHALT

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342.01 SCOPE

This specification covers the requirements for the installation of centreline rumble strips (CRS) into the surface course of asphalt pavement, and the grinding of shoulder rumble strips (SRS) into the surface course of fully or partially paved asphalt shoulders.

342.01.01 Specification Significance and Use

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

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

342.01.02 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.

342.02 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.

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

Ontario Provincial Standard Specifications, Construction

OPSS 313	Hot Mix Asphalt – End Result
OPSS 510	Removal
OPSS 710	Pavement Marking

342.06 EQUIPMENT

The construction equipment shall employ a rotary type cutting head capable of installing rumble strips with a smooth surface to the lines and dimensions as specified in the Contract Documents.

342.07 CONSTRUCTION

342.07.01 General

Centreline rumble strips (CRS) shall be installed at the centreline of the highway as specified in the Contract Documents.

Shoulder rumble strips (SRS) shall be installed at the partially paved asphalt shoulder or fully paved asphalt shoulder as specified in the Contract Documents.

The pavement surface shall be cleaned and all debris shall be disposed of as specified elsewhere in the Contract Documents.

342.07.02 Placement

Centreline rumble strips and SRS shall not be placed within 200 mm of routed and filled transverse joints.

Centreline rumble strips shall be installed prior to the final pavement markings being placed.

Shoulder rumble strips shall be installed after the final pavement markings have been placed. Any damage to the final pavement markings shall be repaired according to OPSS 710.

Where SRS are installed in conjunction with a bicycle buffer zone, the SRS shall be installed prior to the placement of the outer pavement marking edge line.

342.07.03 Tolerances

Tolerances for the width and depth of each rumble strip groove shall be as specified in the Contract Documents. If any one of these tolerances is exceeded in more than two grooves within a one metre length section, the section shall be rejected.

Rejected sections shall be repaired or assessed a payment reduction as directed by the Contract Administrator.

Rejected sections shall be repaired by partial depth asphalt removal according to OPSS 510, replacement of the hot mix asphalt according to OPSS 313, the reinstallation of rumble strips according to this specification, and reinstatement of damaged pavement markings according to OPSS 710. The depth of the partial depth removal shall be 50 mm and the width shall be 500 mm centred over the rumble strip. However, when this will result in a narrow remaining width of asphalt pavement on either side that is less than 300 mm, the removal width shall be extended to include the narrow width of asphalt pavement.

342.09 MEASUREMENT FOR PAYMENT

342.09.01 Actual Measurement

342.09.01.01 Shoulder Rumble Strips - Asphalt Centreline Rumble Strips – Asphalt Shoulder Rumble Strips for Bicycle Buffer Zone - Asphalt

Measurement of rumble strips shall be by horizontal length in metres in which the CRS or SRS have been placed.

342.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

342.10 BASIS OF PAYMENT

**342.10.01 Shoulder Rumble Strips - Asphalt – Item
Centreline Rumble Strips- Asphalt - Item
Shoulder Rumble Strips for Bicycle Buffer Zone – Asphalt - 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 work required by this specification, payment shall be at the Contract prices and according to the specifications for such work.

Appendix 342-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

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR THE INSTALLATION OF INTERLOCKING CONCRETE PAVERS

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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 provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

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

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 1001	Aggregates - General
OPSS 1002	Aggregates - Concrete
OPSS 1004	Aggregates - Miscellaneous
OPSS 1010	Aggregates - Base, Subbase, Select Subgrade, and Backfill Material
OPSS 1860	Geotextiles

CSA Standards

A231.2-95 (R2005)	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 Paver means a precast concrete unit made or field cut with a straight side for placement flush with a concrete curb or other edge restraint.

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.

Laying Face means the exposed working face of a row of concrete pavers on the bedding sand.

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 as specified in OPSS 1002, except that the percent passing the 75µm sieve shall be less than 1%.

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.

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 CAN3-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 Contract 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 22kN per square metre of plate area. The frequency of vibration shall be within the range of 75 to 90Hz.

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.

and to the depth 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 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 be 10 mm or less.

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 pavers broken during the initial compaction shall be removed and replaced prior to the placement of the joint sand and joint sand compaction.

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 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

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR REPAIRING RIGID PAVEMENT WITH PRECAST CONCRETE SLABS

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363.01 SCOPE

This specification covers the requirements for repairing rigid pavement with precast concrete slabs using either the Fort Miller Super-Slab[®] Method or the Michigan Method. The work may include both continuous and intermittent slab repairs.

363.01.01 Specification Significance and Use

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

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

363.01.02 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.

363.02 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.

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

Ontario Provincial Standard Specifications, Construction

OPSS 350	Concrete Pavement and Concrete Base
OPSS 360	Full Depth Repair of Concrete Pavement or Base
OPSS 369	Sealing or Resealing of Joints and Cracks in Concrete Pavement and Concrete Base
OPSS 510	Removal
OPSS 904	Concrete Structures
OPSS 905	Steel Reinforcement for Concrete
OPSS 929	Abrasive Blast Cleaning - Concrete Construction

Ontario Provincial Standard Specifications, Material

OPSS 1002	Aggregates - Concrete
OPSS 1302	Water
OPSS 1350	Concrete - Materials and Production
OPSS 1440	Steel Reinforcement for Concrete
OPSS 1441	Load Transfer Assemblies

Ontario Ministry of Transportation Publications

MTO Laboratory Testing Manual:

LS-602 Sieve Analysis of Aggregates

LS-619 Resistance of Fine Aggregate to Degradation by Abrasion in the Micro-Deval Apparatus

LS-704 Plastic Limit and Plasticity Index of Soils

MTO Materials Engineering and Research Report:

MERO-019 Falling Weight Deflectometer (FWD) Testing Guideline (ISBN 0-7794-8720-6 Print)

CSA Standards

A23.1/23.2-04 Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete

A3000-03 Cementitious Materials Compendium

A3004-C2 Test Method for Determination of Compressive Strengths [Part of CAN/CSA A3000-03, Cementitious Materials Compendium]

ASTM International

C 939-02 Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method)

363.03 DEFINITIONS

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

Bedding Grout means a thin non-structural grout pumped into the grout distribution system that is cast in the bottom of the Fort Miller Super-Slab[®] Method to fill voids beneath the slabs to provide uniform support to the slab.

Cement Treated Base means granular base material stabilized with Portland cement.

Continuous Precast Concrete Slab Repair means the continuous replacement of multiple consecutive slabs of concrete pavement with inter-connecting precast concrete slabs.

Diamond Grinding means altering the profile and texture of a concrete pavement surface by using grinding equipment that employs diamond tip blades.

Intermittent Precast Concrete Pavement Slab Repair means a 2 to 4.5 m long repair carried out using a single precast slab.

363.04 DESIGN AND SUBMISSION REQUIREMENTS

363.04.01 Submission Requirements

363.04.01.01 Precast Concrete Pavement Slab Repair Plan

At least 2 weeks prior to the start of the work, details on the method of the following operations shall be submitted to the Contract Administrator:

- a) Fabrication, transportation, and installation of each precast concrete slab repair method.
- b) Removal of existing concrete (i.e., sawcutting, removal, equipment, and disposal).

- c) Removal of hot mix asphalt repair.
- d) Base preparation.
- e) Precast slab placement.
- f) Grouting (i.e., equipment to be used for mixing and installing).

363.04.01.02 Precast Concrete Mix Design

The precast concrete mix design shall be submitted to the Contract Administrator at least 2 weeks prior to the start of the work.

Documentation shall be included with the submission of the mix design that demonstrates the proposed mix design and materials meet the requirements of this specification, including the air void system in the hardened concrete and the minimum specified 28-Day compressive strength.

All supporting test data shall not be more than 12 months old at the time the concrete mix design is submitted to the Contract Administrator.

363.04.01.03 Flowable Fill Mix Design - Michigan Method

When flowable fill is used as a levelling material, a concrete mix design for flowable fill shall be submitted to the Contract Administrator at least 2 weeks prior to the start of the work. Trial batch documentation shall also be submitted to the Contract Administrator for review a minimum of 7 Days prior to placement.

363.04.01.04 Proprietary Concrete Repair Material (PCRM) - Product Details

At least 7 Days prior to commencement of the work, the name of the PCRM selected for use and the manufacturer's specifications and recommendations for placement shall be submitted to the Contract Administrator. The submission shall also include documentation verifying the suitability of the product for the application and evidence of successful performance in a similar application. The PCRM and supporting information provided shall be acceptable to the Owner.

363.04.01.05 Chipping Hammer

At least one week prior to commencement of the work, a copy of the manufacturer's published specifications on the chipping hammers to be used shall be submitted to the Contract Administrator.

363.05 MATERIALS

363.05.01 Precast Concrete Slabs

363.05.01.01 General

The minimum compressive strength of concrete at 28 Days shall be 30 MPa. Testing of the concrete compressive strength shall be carried out according to CSA A23.2.

The air void parameters of the hardened concrete shall be a minimum air content of 3% and a maximum spacing factor of 0.230 mm.

Concrete shall meet the requirements of the materials section of OPSS 350 and OPSS 1350 with the following exceptions and additions:

- a) Concrete aggregates shall be according to OPSS 1002.
- b) The nominal maximum size of coarse aggregate shall be 19 mm.

363.05.01.02 Finishing

Finishing of precast concrete slabs shall be according to OPSS 350.

363.05.01.03 Texturing of Surface

Texturing of the precast concrete slab surface shall be according to OPSS 350 except that manual devices may be used to provide the required tined texture.

363.05.01.04 Dimensions

Precast concrete slabs shall be full lane width and length of 2 to 4.5 m. Prior to fabrication, the concrete thickness at each repair location shall be determined. Slabs may be cast a maximum of 15 mm thinner than the existing concrete to be repaired to accommodate the bedding material.

363.05.02 Fine Aggregate for Base Preparation - Fort Miller Super-Slab® Method

Fine aggregate for base preparation shall be 100% crushed fine aggregate with a plasticity index of 0% according to LS-704 and a maximum micro-Deval abrasion loss of 35 according to LS-619. Fine aggregate means that portion of aggregate material passing the 4.75 mm sieve when tested according to LS-602.

363.05.03 Flowable Fill - Michigan Method

Flowable fill shall consist of a mixture of Portland cement, coarse and fine aggregate, fly ash, and water, and may contain air entraining admixture or ground granulated blast furnace slag or both.

Portland cement shall be Type GU cement according to CSA A3000.

Fly ash shall be according to CSA A3000.

Coarse and fine aggregate shall meet the requirements of OPSS 1002 and shall have a maximum aggregate size of 12.5 mm.

The compressive strength of the flowable fill mixture shall not be less than 0.5 MPa or greater than 1.0 MPa at 28 Days.

If an air entraining admixture is used, then the air content of the flowable fill shall not exceed 35% of the flowable fill volume.

363.05.04 Bedding Grout - Fort Miller Super-Slab® Method

Bedding grout shall be a mixture of cement, water, and plasticizing admixture. The grout mixture shall have a flow rate of 17 to 22 seconds as measured by ASTM C 939 to ensure fluidity. The compressive strength of the bedding grout shall be a minimum of 2.0 MPa at 12 hours.

363.05.05 Tie Bars and Dowel Bars

Tie bars shall be according to OPSS 1440. Dowel bars shall be according to OPSS 1441.

363.05.06 Expansion Caps for Dowel Bars

Caps shall be tight-fitting and made of compressible, non-absorptive, closed cell polyethylene that will allow approximately 6 mm movement at the end of the dowel bar.

363.05.07 Bond Breaker

Dowel bars shall be coated with RC-250, Tectyl 506, or an approved equivalent.

363.05.08 Proprietary Concrete Repair Material (PCRM)

The PCRM selected shall be suitable for the application.

The minimum compressive strength of the PCRM at 28 Days shall be 30 MPa.

The PCRM for use in the dowel grout of the Fort Miller Super-Slab[®] Method shall be capable of being pumped into the inverted dovetail slots.

363.05.09 Epoxy Adhesives

Epoxy adhesives shall be from the Owner's approved product list and shall be of the type intended for horizontal dowel application and mixed in the cartridge nozzle.

363.05.10 Joint Materials

The joint sealant material shall be according to OPSS 369.

363.05.11 Water

Water shall be according to OPSS 1302.

363.06 EQUIPMENT

363.06.01 Screeding Device for Base Preparation

The screeding device used for fine grading for base preparation shall be laser or otherwise mechanically controlled and shall be capable of fine grading fully compacted fine aggregate or flowable fill to a tolerance of 3 mm.

363.06.02 Gang Drill

The gang drill shall consist of not less than three independently powered pneumatic drills.

363.06.03 Chipping Hammer

Chipping hammers shall be hand held and have a maximum weight of 9.0 kg prior to any handle modification, where applicable, and a maximum piston stroke of 102 mm. All hammers shall have the manufacturer's name and parts or model number engraved on them by the manufacturer. All information shall be clearly legible. The manufacturer's published specifications shall be the sole basis for determining weight and piston stroke.

363.06.04 Gang Saw

The gang saw shall have gang-mounted diamond saw blades and shall be capable of cutting at least 3 parallel slots simultaneously at a slot spacing of 300 mm within a tolerance of 3 mm.

363.06.05 Compressor - Air Blasting

The compressor for air blasting shall have a minimum capacity of 3.5 m³/min. The compressed air shall be free from oil and other contaminants.

363.06.06 Consolidating Equipment

Internal vibrators used to consolidate the PCRM in the dowel bar slots shall have a maximum diameter of 25 mm and shall have a resilient covering that will not damage the epoxy coated reinforcement during use.

363.06.07 Hand Finishing Equipment

Hand finishing equipment shall be according to OPSS 904.

363.06.08 Straight Edges

Straight edges shall be according to OPSS 904.

363.07 CONSTRUCTION

363.07.01 General

Precast concrete pavement slab repairs shall be carried out at the locations identified in the Contract Documents. The work may include both continuous and intermittent slab repairs.

Acceptable methods of intermittent slab repair are the Fort Miller Super-Slab[®] Method and the Michigan Method, as modified by the requirements of this specification.

Acceptable methods of continuous slab repair are the Fort Miller Super-Slab[®] Method as modified by the requirements of this specification, or an alternative continuous precast method with demonstrated and documented good field performance under similar conditions, such as precast, prestressed concrete.

363.07.01.01 Fort Miller Super-Slab[®] Method

In the Fort Miller Super-Slab[®] Method, the work shall consist of fabricating precast concrete pavement slab repairs (i.e., Super-Slab[®]), sawcutting and removing the existing concrete pavement, repairing and compacting the existing subbase, as necessary, placing and grading fine aggregate base material, inserting and securing dowel bars and tie bars, placing precast slabs, installing PCRM in inverted dovetail slots, installing bedding grout beneath the slabs, and sealing of joints.

363.07.01.02 Michigan Method

In the Michigan Method, the work shall consist of fabricating precast concrete pavement slab repairs with dowel bars, sawcutting and removing the existing concrete pavement, constructing dowel bar slots, placing of flowable fill levelling material, placing precast slabs, installing PCRM in dowel bar slots, and sealing of joints.

363.07.01.03**Trial Slab Repair**

Prior to carrying out the precast concrete pavement slab repair, the ability to successfully carry out the slab repair according to this specification shall be demonstrated to the Contract Administrator by placing a trial repair slab within the Contract limits.

In lieu of a trial slab repair, the Contract Administrator may accept evidence demonstrating the ability to successfully conduct the slab repair with the same equipment, placing crew, and methodology to meet the Contract requirements for conducting the slab repair on any Contract within the last 12 months.

The trial slab repair shall be conducted on both the intermittent slab and continuous slab. The location of the trial slab repair shall be proposed to the Contract Administrator for approval. The Contract Administrator shall be given a minimum of 48 hours notice prior to the trial slab repair.

The Contract Administrator shall allow the slab repair work to continue based on an acceptable visual assessment of the trial. When the slab repair is rejected by visual assessment, additional trial slab repairs shall be performed until the slab repair meets the requirements of this specification.

Unacceptable trial repair slabs shall be repaired, removed, or reinstalled, as required.

363.07.02**Operational Constraints**

Perimeter sawcutting of the removal area shall not be carried out more than 1 week in advance of the expected date of repair.

Bedding grout and dowel grout shall be carried out as soon as possible after the installation of the precast concrete pavement slab.

The temperature of the flowable fill mixture used for the Michigan Method, as manufactured and delivered, shall be at least 10 °C. Placement of flowable fill shall not be allowed if the anticipated air temperature will be 2 °C or less in the 24 hour period following proposed placement.

The PCRM shall not be placed when the air temperature is outside the manufacturer's recommended temperature range or is likely to fall or rise outside the range throughout the duration of the material placing operation. Prior to placing the PCRM, it shall be demonstrated to the Contract Administrator that the existing concrete temperature in the repair area meets the manufacturer's requirements by measuring and recording the substrate temperatures using a contact thermometer or infrared thermometer.

Construction vehicles, equipment, or traffic shall not be permitted to travel on the precast repair until the PCRM has attained a minimum compressive strength of 20 MPa.

Each repair location shall be completed within the time period specified in the Contract Documents. If the repair is not progressing at a rate that will permit the full restoration of traffic within the allowable time period, appropriate measures acceptable to the Contract Administrator shall be undertaken to allow opening of the road to traffic. Full depth precast concrete slab repairs shall replace the above temporary work during the next scheduled closure.

363.07.03**Removals**

A template shall be used to precisely delineate the limits of the areas to be repaired within a tolerance of 12 mm. Repairs shall be the full width of the lane and full depth of concrete or hot mix asphalt repair.

Concrete removal shall be carried out according to OPSS 510. The outer limits of the removal area shall be sawcut full depth and shall not be overcut by more than 250 mm into the adjacent concrete that is to remain in place. Overcuts shall be filled with a proprietary product acceptable to the Owner.

Concrete removal shall be by lift-out method. Removals shall be carried out without damaging the adjacent concrete pavement or asphalt shoulder or disturbing the underlying base. Heavy breaking equipment such as hoe rams shall not be used in the removal operation. The concrete pavement shall not be broken in place.

If the adjacent concrete is damaged or cracked due to the removal procedure, the damaged concrete shall be repaired according to OPSS 360. Asphalt surfaces damaged during the removal process shall be repaired. A proposal for repairs shall be provided to the Contract Administrator for approval.

363.07.04 Base Preparation

363.07.04.01 General

Levelling material shall be either a flowable fill for the Michigan Method or fine aggregate for the Fort Miller Super-Slab[®] Method meeting the requirements of this specification.

Micro-grinding of the existing cement treated base is recommended if minor adjustment for the base level is required.

363.07.04.02 Flowable Fill - Michigan Method

The batching equipment shall have devices designed to measure the specified quantities of each component material and mixing shall be of sufficient duration to ensure uniform consistency of the mixture. Water content shall be maintained so that compressive strengths are achieved and a uniform, flowable mixture is developed that is essentially self-levelling when placed.

363.07.04.03 Fine Aggregate - Fort Miller Super-Slab[®] Method

Fine aggregate shall be compacted then fine graded using a screeding device capable of grading the fully compacted bedding material to the required tolerance.

363.07.05 Steel Reinforcement

Steel reinforcement shall be according to OPSS 905.

363.07.06 Dowel Bar Installation - Michigan Method

363.07.06.01 Sawcutting Dowel Bar Slots

Slots shall be created using gang saws. The slots shall be 65 mm wide by 450 mm long and to a maximum depth to allow the dowel bar to be placed at mid-slab depth with 12 mm cover under the bar. The slots shall be parallel to the centreline of the roadway with a maximum tolerance of 3 mm from a parallel line.

Equipment shall not cause damage to the existing pavement. All slurry from the sawcutting operation shall be removed from the slot and pavement. Over-cutting dowel bar slots is not permitted.

363.07.06.02 Concrete Removal in Dowel Bar Slots

Chipping hammers shall be used to remove concrete within the slots. Concrete shall be removed to ensure the bottom of the slot is level and in such a manner as to prevent damage to the concrete remaining in place. If the concrete removal operation causes damage to the adjacent concrete pavement, corrective action shall be taken immediately.

If during the removal process the adjacent concrete is damaged due to the removal operation, the damaged concrete shall be repaired as a partial depth repair according to OPSS 360.

The chipping hammers shall not be permitted to break through the concrete. In the event of a break through or if a crack develops within a slot, the repair shall be treated as a full depth repair and the entire joint within the lane shall be removed and replaced with a 2 m full depth concrete repair according to OPSS 360.

363.07.06.03 Slot Cleaning

All concrete surfaces within the slot shall be solid, free from loose or unsound fragments. All concrete surfaces shall be abrasive blast cleaned according to OPSS 929 and all dust and loose material shall be removed from the prepared surface by using compressed air.

363.07.06.04 Placing the PCRM in Dowel Bar Slots - Michigan Method

All concrete surfaces within the slot shall be in accordance with manufacturer's requirements. Care shall be taken to prevent standing water in the slot. Prior to placing the PCRM, all excess water shall be removed with compressed air.

The treatment of the concrete surfaces within the slot with a bonding agent, if required by the manufacturer, and the mixing, placing, finishing, and curing of the PCRM shall be done according to the manufacturer's recommendations. A metering or measuring device shall be used to establish the correct amount of mixing water. All batches of PCRM shall be consistent.

PCRM shall not be spilled onto the adjacent concrete surface when placing in slots. The PCRM shall be vibrated to consolidate the material into the slot and around the dowel bar.

The PCRM shall be finished flush with the surface of the concrete and all excess material removed immediately. Hand finishing shall be minimized to prevent overworking of the repair. The PCRM shall be cured according to the manufacturer's recommendations.

363.07.07 Dowel Bar and Tie Bar Installation - Fort Miller Super-Slab® Method

Gang drills shall be used to drill holes in the existing concrete for insertion of dowel bars. The diameter of the drill holes shall be no more than 5 mm larger than the diameter of the dowel bars or tie bars. Drill holes shall be thoroughly cleaned by air blowing from the back of the drill hole outwards. Drilling equipment shall be used in a manner to ensure adjacent pavement is not damaged.

Dowel bars and tie bars shall be secured into the existing concrete with an epoxy adhesive. The epoxy adhesive shall be injected into the back of the cleaned drill hole and the dowel bar or tie bar with grout retention disks attached, and shall be inserted to ensure the bars are completely encased with epoxy adhesive for the full depth of the hole. Tie bars and dowel bars shall be installed as specified in the Contract Documents. Tie bars are only required for continuous repairs.

363.07.08 Slab Installation - Fort Miller Super-Slab® Method

Slabs shall be guided into position during installation using guide bars inserted in bedding grout port holes to align slabs during setting. The use of pry bars or wedges in joints for alignment purposes shall not be permitted.

The vertical differential between adjacent slabs shall be less than 6 mm. If the vertical differential is greater than 6 mm, the slab shall be removed, the base re-graded, and the slab reset until the differential is less than 6 mm prior moving on to the next slab.

If slabs are to be opened to traffic before they are grouted, incompressible shims shall be placed at approximate ¼ points in both the transverse and longitudinal joints to maintain horizontal alignment of the new precast slabs until they are grouted.

If un-grouted slabs are vertically displaced so that the vertical differential is greater than 6 mm as described above, the slab shall be removed, the base re-graded, and the slab reset prior to grouting, or the surface shall be brought to the required tolerance by grinding as required by this specification.

363.07.09 Placing the Dowel Grout and Bedding Grout - Fort Miller Super-Slab® Method

Foam grout dams shall be installed at the open ends of the transverse joint to be grouted to prevent dowel grout from escaping during the installation. Dowel grout shall be mixed in strict accordance with the instructions provided by the manufacturer. The volume of water shall be measured accurately for each batch by weighing the batch water or by using calibrated pails that are perforated at a level to ensure the correct amount of water is mixed with each bag of grout. Dowel grout shall be pumped in the back port of each dowel slot until it comes out the second port in the same slot. Foot shall be placed over the second port and pumping shall be continued until the grout flows along the joint to the next slot. The same procedure shall be repeated for the back port of the next slot. The grout level in previously filled ports shall be continually monitored. Grout shall be added, as necessary, to keep the grout level in the ports even with the top of the slab and in the joints above the top of the slots.

Bedding grout shall be placed after the dowel grout has been installed. Bedding grout shall be mixed in strict accordance with the instructions provided by the manufacturer of the viscosity-reducing admixture. Bedding grout shall be pumped in the lowest port of the slab until it comes out the corresponding port at the other end of the slab. While filling the remaining ports in the slab, the grout level shall be continually monitored in previously filled ports and grout added, as required, to keep the grout level in the ports even with the top of the slab. This will maintain a safe and adequate head pressure on the bedding grout until all voids under the slab are filled.

Before the bedding grout fully sets, the top 50 mm of bedding grout in each port shall be removed and replaced with PCRM. The PCRM in all ports shall be finished flush and matching with the surface of the concrete and all excess material removed immediately.

363.07.10 Tolerances

363.07.10.01 Dowel Bar and Tie Bar Tolerances

Dowel bars shall be installed mid-depth of the concrete slab in a plane with the pavement surface and parallel to the centreline of the road. Tie bars shall be installed mid-depth of the concrete slab in a plane with the pavement surface and perpendicular to the longitudinal lane edge sawcut face. The tolerance for the alignment of dowel bars and tie bars shall be ± 15 mm along the length of the bar in both the vertical and horizontal planes of the pavement and parallel to the direction of traffic.

363.07.10.02 Surface Tolerances

The surface of the precast concrete slab repair shall join flush with the existing concrete pavement. Surface tolerance of intermittent repair slabs shall be so that when tested with a 3 m long straight edge placed in the longitudinal direction there shall not be a gap greater than 6 mm between the bottom of the straight edge and the surface of the pavement. Surface tolerance of continuous slabs shall be so that the gap is not greater than 6 mm when the straight edge is placed in any location and direction, including the edge of pavement, except across the crown or drainage gutters.

363.07.11 Joint Sealing

All longitudinal and transverse joints shall be sealed according to OPSS 369.

363.07.12 Sampling and Testing

363.07.12.01 General

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 subplot number.
- h) Sample location.

363.07.12.02 Compressive Strength of Concrete in Precast Slab

Concrete test cylinders shall be cast, cured, handled, and delivered for 28-Day compressive strength testing according to OPSS 1350 based on 1 set of 2 cylinders taken for each batch of concrete.

363.07.12.03 Compressive Strength of Flowable Fill

The compressive strength of the flowable fill shall be determined by casting cylinders. Two sets of two standard 150 x 300 mm cylinders to represent a day's placement shall be cast, cured, and delivered. Cylinders for testing the 3-Day and 28-Day compressive strengths shall be stored and cured according to OPSS 1350, then transported to a quality assurance (QA) laboratory designated by the Owner in the Contract Documents. Testing for 28-Day compressive strength shall be conducted according to OPSS 1350, except that specimens shall be air cured in their moulds until they are to be tested.

363.07.12.04 Compressive Strength of Proprietary Concrete Repair Materials and Bedding Grout

Samples of PCRM shall be taken from the mixer in the field for the determination of the early strength and 28-Day compressive strength. The PCRM shall be moulded into cubes according to CAN/CSA A3004-C2.

Cubes shall be prepared on-site from the PCRM to be used to fill the slots. For the 28-Day compressive strength, the PCRM shall be sampled once for every 4 hours of production or a minimum of once per day, whichever is greatest. One set of six cubes shall be made from each sample of PCRM.

Additional cubes for determination of early strength shall be prepared. One set of six cubes shall be made for the final repair area of each closure. These cubes shall be tested to verify that the PCRM in the repair area has attained a compressive strength of 20 MPa. These test results shall be communicated immediately to the Contract Administrator prior to opening to traffic.

The timing of testing and frequency of testing of the early strength cubes shall be determined when the PCRM has attained a minimum compressive strength of 20 MPa.

The specimens shall be stored at a temperature between 15 °C and 25 °C and shall not be moved prior to demoulding. The specimens shall be demoulded and transported to the QA laboratory designated by the Owner within 24 hours $\pm$ 4 hours. The samples shall be transported in a sealed white opaque plastic bag containing at least 250 ml of water and maintained at a temperature between 15 °C and 25 °C.

363.07.12.05 Falling Weight Deflectometer Testing

Falling weight deflectometer (FWD) testing shall be carried out on the approach and leave joints of each precast slab to determine the load transfer efficiency across the transverse joints. FWD testing, equipment calibration, and reporting shall be according to MERO-019 using the Load Transfer test with a Detailed Project Level data collection scenario and a JCP Test Plan configuration.

363.07.13 Repair or Removal of Unacceptable Concrete

Precast concrete pavement slabs that arrive on the job site cracked, honeycombed, or showing any other visually detectable deficiencies shall be rejected and not used in the work.

Precast concrete pavement slabs that do not meet the surface tolerance requirements shall be removed and replaced, or corrected by diamond grinding.

Concrete pavement adjacent to precast concrete slab repair, damaged or displaced during installation of the precast repair shall be removed and replaced with new concrete as specified.

363.07.14 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

363.08 QUALITY ASSURANCE

363.08.01 Inspection

Prior to installation and with notification, access shall be provided to the Contract Administrator to inspect the precast concrete pavement slabs to ensure that they are properly textured and crack-free without any honeycombing or other visually detectable deficiencies.

363.08.02 Acceptance or Rejection

Prior to opening to traffic, access shall be provided to the Contract Administrator to inspect the precast concrete slab repairs to determine if the completed work contains:

- a) Cracking or spalling.
- b) Ungrouted saw over-cuts from the removal process.
- c) Rocking of precast concrete pavement slab.
- d) Precast concrete pavement slab that does not meet surface tolerance.

Precast concrete pavement slab repairs shall be rejected based on the presence of one or more of the defects identified above or one or more of the following conditions:

- a) FWD testing results indicate a load transfer efficiency of less than 70%.
- b) Compressive strength of the precast slab less than 30 MPa at 28 Days.
- c) Air content of the hardened concrete in the precast slab is less than 3% or spacing factor is greater than 0.230 mm.

A detailed remedial plan shall be submitted to the Contract Administrator for approval to address identified deficiencies.

363.09 MEASUREMENT FOR PAYMENT

363.09.01 Actual Measurement

363.09.01.01 Precast Concrete Slab Repair

Measurement of the precast concrete slab repair placed shall be by area in square metres. The total area shall be calculated to the nearest 0.1 m².

363.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clause under Actual Measurement.

363.10 BASIS OF PAYMENT

363.10.01 Precast 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.

Measures taken to permit full restoration of traffic within the allowable time period shall be at no additional cost to the Owner.

Precast concrete pavement slabs that do not meet surface tolerance requirements shall be either removed and replaced or repaired by diamond grinding at no additional cost to the Owner.

Precast concrete pavement slabs rejected by the Contract Administrator shall be removed and replaced with new concrete as specified elsewhere in the Contract Documents at no additional cost to the Owner.

Concrete adjacent to and damaged by the removal process shall be cut back full depth to sound concrete and replaced at no additional cost to the Owner.

Asphalt surfaces damaged during the removal process shall be repaired at no additional cost to the Owner.

Full-depth repairs required as a result of chipping hammers breaking through the concrete or a crack developing as a result of chipping operations shall be carried out at no additional cost to the Owner.

Appendix 363-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

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



**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 provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

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

365.01.02 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.

365.02 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.

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 cartridge. Epoxy adhesive shall be supplied from a source on the ministry 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 m³/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 and shall be installed within the following tolerances:

- a) Drilling angle: $\pm 1^\circ$
- b) Drill hole depth: ± 5 mm
- c) Drill hole diameter: ± 1 mm
- d) Drill hole offset from longitudinal crack: ± 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 Longitudinal Cracks in Concrete Pavement and Concrete Base

For measurement purposes, a count shall be made of the number of cross-stitching 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 Longitudinal 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.

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 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

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



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 sanitary and storm pipe sewers; pipe culverts and end sections; pipe subdrains; forcemains and associated appurtenances; watermain and associated appurtenances; and other underground Utilities.

401.01.01 Specification Significance and Use

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

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 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.

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 of Pipeline, Utility, and Associated Structure Excavation
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

Occupational Health and Safety Act

R.S.O. 1990, c. O.1, as amended

Ontario Regulations 213/91 - Regulations for Construction Projects, as amended

401.03 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.

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.

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.

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 Ontario Regulations 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 Embedment Material

Embedment material shall be one of the following, 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 Bedding Material

Bedding material shall be one of the following, 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.

401.05.03 Cover Material

Cover material shall be one of the following, 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) Native material.

401.05.04 Granular Material

Granular material shall be according to OPSS 1010.

401.05.05 Backfill Material

401.05.05.01 General

Backfill material shall be one of the following, as specified in the Contract Documents:

- a) Granular A.
- b) Granular B, Type I, II, or III.
- c) Unshrinkable fill.
- d) Native material.

401.05.05.02 Native and Imported Material

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.

401.05.06 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 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 structure.

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 class of bedding 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

The diameter or the span and rise of flexible pipes shall not vary from the manufactured dimensions by more than 5% during cover and backfill placing operations.

Pipe installation and backfilling shall be completed prior to the start of subbase and base course construction over the pipe location.

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 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.

Backfill material shall be placed to a minimum depth of 900 mm above the crown of the pipe before power operated tractors or rolling equipment shall be used for compacting. Uniform layers of backfill material exceeding 300 mm in thickness may be placed with the approval of the Contract Administrator.

When the Contract specifies native backfill material, acceptable earth backfill material may be substituted with the approval of the Contract Administrator. In areas within the roadway, for a depth equal to the frost treatment, the earth backfill material shall have frost susceptible characteristics similar to the adjacent material.

401.07.11 Additional Trenching, Backfilling, and Compacting

Additional 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 Additional Trenching, Backfilling, and Compacting

Additional trenching, backfilling, and compacting shall be based on the volume of the additional 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 sanitary and storm pipe sewers, pipe culverts and end sections, subdrains, forcemains and associated appurtenances,

watermains and associated appurtenances, and other underground Utilities 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 borne by the Contractor.

When native material is deemed unsuitable for backfill for reasons other than those attributed to the Contractor's mode of operation, any additional work done to provide acceptable backfill beyond the work herein specified shall be administered as a Change in the Work.

401.10.02 Additional 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 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

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR PIPE SEWER INSTALLATION IN OPEN CUT

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410.07	CONSTRUCTION
410.08	QUALITY ASSURANCE - Not Used
410.09	MEASUREMENT FOR PAYMENT
410.10	BASIS OF PAYMENT

APPENDICES

410-A	Commentary

410.01 SCOPE

This specification covers the requirements for the installation and inspection 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 provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

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 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.

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]
G401 Corrugated Steel Pipe Products

ASTM International

B 746 Corrugated Aluminum Alloy Structural Plate for Field-Bolted Pipe, Pipe-Arches, and Arches;
C 507-12 Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe

Other

WRC Manual of Sewer Condition Classification (MSCC), Fourth and/or Third Edition

410.03 DEFINITIONS

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

Acceptable Pipe Condition Status means the assessment designation assigned to an installed gravity pipe installation that has no deficiencies.

Aluminum Alloy means a material made with two or more metals in which aluminum is the predominant metal.

Backfilling means the operation of filling the trench with bedding, cover, and backfill material or embedment and backfill material.

CCTV means closed-circuit television used to inspect a gravity pipe installation.

Certification Body means an independent 3rd party agency accredited by the Standards Council of Canada that has the qualifications, skills, and expertise required to confirm that a pipe manufacturer produces pipe products to the quality and requirements of an accepted standard and that has the mandate to certify the pipe products produced.

Certified means pipe products that have been marked with a certification body's logo confirming that the production of the pipe product is in accordance with the quality and requirements of the manufacturing standard.

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.

Delivered Quality means the pipe products' physical condition upon arrival at the construction site in terms of the extent and degree of dents, scratches, cracks, pipe coating integrity, etc., that appear on the pipe products delivered.

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.

Gravity Pipe Installation means a constructed pipe system conveying surface waters under the influences of gravity only and can be a pipe sewer or a pipe culvert.

Inspection Assessment means evaluating the findings of a post installation inspection and quantifying the pipe condition status of the gravity pipe installation.

Laser Profiler means an instrument that uses a light ring to survey, locate, measure and report profile, deflection and dimensional attributes, including anomalies, in a gravity pipe installation.

Mandrel means an instrument equipped with an odd number of arms that is pulled through a flexible gravity pipe installation to determine deflection anomalies.

NASSCO means the National Association of Sewer Service Companies which certifies inspectors to perform inspection of pipe sewers and culverts and code viewed pipe conditions.

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 Condition Coding means the assignment of code designations to pipe attributes such as pipe materials, walls, joints, service connections or any other physical pipe characteristics.

Pipe Condition Status means the designation assigned to the gravity pipe installation based on the assessment of the post installation inspection results.

Pipe Condition Assessment Rating means the final gravity pipe installations' acceptance rating that is given to the pipe based on the evaluation of the final post installation inspection results inclusive of both original and additional test segments from the post installation inspection, referee post installation inspection and follow up repair inspection.

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.

Post Installation Inspection means quantifying the final installed condition of gravity pipe installations using accepted surveillance and measuring methods.

Reject Pipe Condition Status means the designation assigned to an installed gravity pipe installation, pipe lengths, pipe fittings and/or pipe service connections that have deficiencies that cannot be repaired to maintain the structural integrity or design service life of the gravity pipe installation or has certain measurable pipe attributes that are beyond Owner acceptance limits.

Repair Pipe Condition Status means the designation assigned to an installed gravity pipe installation, pipe lengths, pipe fittings and/or pipe service connections that have deficiencies that can be repaired to maintain the structural integrity and design service life of the gravity pipe installation.

Repaired Pipe Condition Status means the designation assigned to installed gravity pipe installations, pipe lengths, pipe fittings and/or pipe service connections with a Repair Pipe Condition Status that have been repaired using acceptable intrusive repair measures.

Replacing means the removal of any gravity pipe installations, pipe lengths, pipe fittings and/or pipe service connections and reinstalling the gravity pipe installation, pipe lengths, pipe fittings and/or pipe service connections to contract specifications.

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.

Threshold Pipe Condition Status means the designation assigned to an installed gravity pipe installation, pipe lengths, pipe fittings and/or pipe service connections that have certain measurable pipe attributes that are beyond accepted construction limitations but are still within Owner acceptance limits and requires no remediation actions.

Test Segment means an individual sewer pipe run or pipe culvert that has been selected to have a post installation inspection performed on it.

Visual Observation Inspection means coding and describing the profiles, deflection and dimensional features, including anomalies, in a gravity pipe installation using direct human entry into the pipe sewer run or pipe culvert.

Zoom Camera means a stationary video camera fitted with a tele-objective zoom lens and high-powered floodlights and used to inspect a gravity pipe installation.

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.

Steel structural plate pipe with polymer coating shall be according to CSA G401.

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.

410.05.01.07 Aluminum Alloy Pipe Products

Corrugated aluminum alloy structural plate pipe products shall be according to ASTM B746.

All corrugated aluminum alloy structural plate pipe products used on the Contract shall be certified and supplied from a manufacturer that produces the corrugated aluminum alloy structural plate pipe products according to ASTM B746. Only products with an accepted certification body logo marking as shown in Figure 1 shall be used.

Inspection, testing, and record keeping for corrugated aluminum alloy structural plate pipe products shall be according to ASTM B746.

Certified corrugated aluminum alloy structural plate pipe shall be marked according to ASTM B746, and shall include as a minimum the logo of the certification body and name of the pipe manufacturer.

When requested by the Owner, a copy of the certificate of compliance issued by the certification body confirming that the manufacturer produces certified corrugated aluminum alloy structural plate pipe products shall be submitted to the Contract Administrator.

The cost of all testing, except that performed in the Owner's laboratory, shall be included in the price.

Where the delivered quality of certified corrugated aluminum alloy structural plate pipe products is deemed to be unacceptable by the Contract Administrator, the products shall be rejected.

410.05.02 Mortar

Mortar for joints shall be composed of one part normal 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 normal 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
- g) Mechanical Restrained Joint with Gasket

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.

410.07.12.08 Corrugated Aluminum Alloy Structural Plate Pipe

Corrugated aluminum alloy structural plate pipe shall be jointed by means of bolts 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 Post Installation Inspection

The post installation inspection of pipe sewers shall be carried out by the Contract Administrator as specified in the Quality Assurance section under the following conditions:

- a) When the total combined pipe sewer length of all pipe sewer tender items is greater than or equal to 500 m; or
- b) If the total pipe sewer length of all pipe sewer tender items is less than 500 m, when at least one sewer pipe run is constructed with a pipe diameter greater than or equal to 450 mm and is greater than or equal to 50 m in length.

A competent and authorized representative of the Contractor, by completing Form PH-CC-822PIC (Sewer Section), shall certify that all pipe sewer installations, within the highway section identified, have been installed and completed in general conformance with the Contract Documents and are ready for the post installation inspection. Submission of Form PH-CC-822PIC shall be deemed to be the request to the Contract Administrator to have the post installation inspection performed at the certification stage indicated on the form. A separate Form PH-CC-822PIC shall be submitted for each construction season of the Contract to have the post installation inspection apportioned by construction season.

The Contract Administrator, upon approving the Contractor's request, within five Business Days of receipt of Form PH-CC-822PIC, shall provide notification of the start date of the post installation inspection.

Upon commencement of the post installation inspection, construction work shall be discontinued temporarily in the vicinity of a pipe sewer being inspected until the inspection of that pipe sewer has been completed.

410.07.17 Cleaning and Flushing of Pipe Sewers

At least two Business Days prior to the commencement of the post installation inspection, pipe sewers shall be prepared for inspection by cleaning and flushing. The material from the cleaning and flushing operation shall be managed as specified elsewhere in the Contract.

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.

410.08 QUALITY ASSURANCE

410.08.01 Acceptance

Acceptance shall be according to this specification, including satisfactory completion of all replacement and remedial actions associated with identified deficiencies.

410.08.02 Post Installation Inspection Procedures

Notwithstanding that inspection for compliance with the Contract Documents will be performed during the Contractor's installation of the pipe sewers, the Contract Administrator shall carry out the post installation inspection on a number of test segments. The number of test segments per pipe sewer tender item shall account for a minimum of 25% of the total pipe sewer length on the Contract for the purpose of defining the quality of workmanship and acceptability of the pipe sewer installations.

On contracts with less than 4 pipe runs, a minimum of one test segment shall be inspected.

Selected test segments constructed with rigid pipe materials will be inspected using CCTV, zoom camera or by visual observations. Selected test segments constructed with flexible pipe materials will be inspected using CCTV, zoom camera or by visual observations and shall also be inspected for deflection using a mandrel, laser profiler or by direct measurement.

The Contract Administrator shall randomly select the test segments to be inspected on the Contract. If inspecting in a construction season, the number of test segments selected shall be apportioned across all construction seasons to comprise the total amount of test segments to be inspected.

Selected test segments shall be inspected throughout their entire length.

All CCTV, zoom camera or visual observation operations for a post installation inspection shall be performed by a certified NASSCO inspector. The certified NASSCO inspector shall also be responsible to carry out all mandrel, laser profiling or direct measurement operations on flexible test segments.

The Contractor may be present during inspection operations.

Pipe sewers that are to be installed in a preloaded or surcharged condition as specified in the Contract Documents will not be selected as a test segment and will not be subject to payment adjustments. However, these pipe sewers may be subject to a post installation inspection should poor performance and/or service arise after installation. Upon assessment of the post installation inspection submission, any repair or replacement issues shall be dealt with on a case by case basis.

410.08.03 Post Installation Inspection Assessments

The Contract Administrator shall assess the post installation inspection submissions for each test segment inspected quantifying the pipe condition statuses as per the pipe condition codes shown in Table 3.

Within 20 Business Days of receipt of Form PH-CC-822PIC, the Contract Administrator shall, for all test segments inspected, provide the Contractor, with copies of all test segment post installation inspection submissions and assessments. This will serve as notification to the Contractor if further action, based on the test segments' pipe condition statuses, is required.

410.08.04 Replacement and Repair

410.08.04.01 Replacement

All individual pipe lengths and/or joints in a test segment assessed with a "Reject" Pipe Condition status shall be replaced by the Contractor by installing new pipe lengths, service connections and/or joints as required.

The Contract Administrator shall, upon written notification from the Contractor that replacement operations have been completed, perform a replacement post installation inspection of all test segments where pipe lengths and/or joints have been replaced and shall assess the test segments' pipe condition statuses based on the replacement post installation inspection.

410.08.04.02 Repair

All individual pipe lengths and/or joints in a test segment assessed with a "Repair" Pipe Condition status shall be repaired by the Contractor.

Table 2 lists lists Owner accepted repair methods and pipe material application that may be used.

The Contractor shall submit a repair proposal to the Contract Administrator within five Business Days after receipt of the test segments' post installation inspection submissions and assessments. The Contract Administrator shall review the repair proposal within three Business Days.

Upon approval by the Contract Administrator, the Contractor shall carry out the repairs of the pipe lengths and/or joints in the test segment in accordance with the approved repair proposal.

All repair methods, measures and materials used shall be documented.

The Contract Administrator shall, upon written notification from the Contractor that repair operations have been completed, perform a follow up repair inspection on the pipe lengths and/or joints in the test segment that have been repaired to confirm that the repairs have been made by the Contractor as approved.

Notwithstanding where a test segment or portion of the test segment has been assessed by the Contract Administrator with a "Repair" Pipe Condition status and upon attempting to implement the approved repair proposal, the Contractor determines that the proposed repair measures cannot repair the test segment or portion of the test segment; the test segment or portion of the test segment shall be replaced by the Contractor.

The Contract Administrator shall, upon written notification from the Contractor that replacement operations have been completed, perform a replacement post installation inspection of the test segment in its entirety upon completion of the replacement of the test segment or portion of the test segment and shall assess the test segments' pipe condition statuses based on the replacement post installation inspection.

410.08.05 Acceptance

A pipe sewer tender item shall be accepted based on the post installation inspection assessment of selected test segments that comprise, at a minimum, 25% of the pipe quantity for that pipe sewer tender item. Additional test segments shall be added as described elsewhere in this specification.

Inspected test segments shall be assessed as follows:

Individual test segments or portions of a test segment and/or the joints in a test segment that received no Pipe Condition Code are assessed with an Acceptable Pipe Condition rating, and are not subject to price adjustment.

Individual test segments or portions of a test segment and/or the joints in a test segment that received a Repair Pipe Condition rating, and where the Contract Administrator has confirmed that the Contractor has performed the repairs using non-intrusive repair methods, are deemed acceptable and shall be upgraded to a final Acceptable Pipe Condition rating, and as such are not subject to a price adjustment.

If there are more than 2 repair deficiencies per linear metre or a common repair deficiency is found on 15% or more of the pipe lengths or joints in the test segments inspected where non-intrusive repair measures were used to perform the repairs, the Contract Administrator shall randomly select, at a minimum, an equivalent amount of additional test segments for the post installation inspection.

Individual test segments or portions of a test segment and/or the joints in a test segment that received a Threshold Pipe Condition rating are acceptable, however, are subject to a price adjustment.

If there are more than 2 threshold deficiencies per linear metre or a common threshold deficiency is found on 25% or more of the pipe lengths and/or joints in the test segments inspected, the Contract Administrator shall randomly select, at a minimum, an equivalent amount of additional test segments for the post installation inspection.

Individual test segments or portions of a test segment and/or the joints in a test segment that received a Repair Pipe Condition rating, and where the Contract Administrator has confirmed that the Contractor has performed the repairs using intrusive repair methods, are deemed to be adequate and the entire test segment shall be upgraded to a final Repaired Pipe Condition rating, however, is subject to a price adjustment.

If repair deficiencies were found and intrusive measures were used to repair an individual test segment or portions of test segments, the Contract Administrator shall randomly select, at a minimum, an equivalent amount of additional test segments for the post installation inspection.

Individual test segments or portions of a test segment and/or joints in a test segment that received a Reject Pipe Condition rating are not acceptable.

Of the individual test segments or portions of a test segment and/or the joints in the test segments inspected, if 10% or more of the test segments and/or joints received a Reject Pipe Condition rating, the Contract Administrator shall randomly select, at a minimum, an equivalent amount of additional test segments for the post installation inspection.

410.08.06 Referee Testing

The Contractor may request referee testing on individual test segments or portions of a test segment that received a "Repair", "Reject" or "Threshold" Pipe Condition Status.

Referee testing may only be invoked within five Business Days of the Contractor receiving copies of the test segments' post installation inspection submission and the assessment results.

Referee testing shall be done through the following procedure:

- a) The Contractor shall identify the assessments of individual test segments or portions of any test segments that they disagree with;
- b) The Contract Administrator shall arrange for a referee post installation inspection to be performed by an independent NASSCO certified, third party inspector using the same inspection criteria, type of

equipment and techniques as was used for the original post installation inspection on the test segments under disagreement;

- c) The Contract Administrator shall assess the referee post installation inspection submission, which replaces the original post installation inspection submission, for each test segment or portions of test segments under disagreement which will then be binding on both parties; and
- d) The Contract Administrator shall provide the Contractor with copies of the test segment referee post installation inspection submissions and assessments which will serve as notification to the Contractor if further action, based on the pipe condition statuses, is required.

410.08.07 Final Pipe Condition Assessment Rating

The Contract Administrator shall assign final Pipe Condition Assessment Ratings (PCAR) as follows:

A PCAR of "R" is assigned to those test segments that, either in part or in whole, initially received a Repair Pipe Condition Status and have been upgraded to a Repaired Pipe Condition Status;

and for the remaining test segments:

A PCAR of "A" is assigned to the portion of these remaining test segment lengths that received an Acceptable Pipe Condition Status; and

A PCAR of "T" is assigned to the portion of these remaining test segment lengths that received a Threshold Pipe Condition Status.

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, subject to the payment adjustments as specified in this specification.

Costs for the replacement and/or repair of test segments including but not limited to the associated costs for the reinstatement of the highway structure and all ancillary features previously constructed above the test segments shall be at the Contractor's expense at no additional cost to the Owner. Costs for any delays associated with the repair and/or replacement of the test segments and the reinstatement of the highway structure and all ancillary features previously constructed above the test segments shall also be at the Contractor's expense at no additional cost to the Owner.

The cost of traffic control for the post installation inspection shall be at the Contractor's expense at no additional cost to the Owner.

The cost for inspection of additional test segments in the post installation inspection, follow up repair inspection and/or replacement post installation inspection, including traffic control, according to the Acceptance of Pipe Sewers clause shall be at the Contractor's expense at no additional cost to the Owner.

The cost for referee post installation inspection, including traffic control, according to the Referee Testing clause shall:

- a) Where the assessment of the referee post installation inspection confirms the original pipe condition status, be borne by the Contractor; or
- b) Where the assessment of the referee post installation inspection upgrades the original pipe condition status, be borne by the Owner; or
- c) Where the assessment of the referee post installation inspection upgrades a portion of the original pipe condition status, be apportioned between the Contractor and the Owner based on the final upgraded and confirmed pipe proportions respectively.

410.10.02 Price Adjustment Factor

Price Adjustment Factors (PAF) for each PCAR is noted as follows:

PCAR of "A" is subject to a PAF equal to 1;

PCAR of "R" is subject to a PAF equal to 0.75. and

PCAR of "T" is subject to a PAF equal to 0.85.

410.10.02.01 Application to Pipe Sewer Tender Items

A Weighted Price Adjustment Factor (WPAF) is calculated for each pipe sewer tender item that had test segments inspected and is applied against that pipe sewer tender item only. Each pipe sewer tender item that had test segments inspected will have a unique WPAF.

Any test segments with a PCAR of "R" are price adjusted separately as described in the Application to Repaired Test Segments clause.

The WPAF for a pipe sewer tender item is calculated using the total pipe length of those remaining test segments that have PCAR of "A" and "T" only.

The Contract Administrator shall calculate the WPAF for a pipe sewer tender item based on the "A" and "T" portions of the remaining test segments lengths, as follows:

WPAF =

$$\frac{\text{PAF (A) x "A" portion of remaining test segments' length} + \text{PAF (T) x "T" portion of remaining test segments' length}}{\text{Total pipe length of remaining test segments}}$$

This WPAF shall be applied to determine the payment adjustment for the tender item quantity minus the total quantity of test segments in that tender item that have a PCAR of "R".

410.10.02.02 Application to Repaired Test Segments

This individual WPAF is applied to all test segments that are rated "R". A separate WPAF is calculated for each test segment that is rated "R" within a pipe sewer tender item.

The Contract Administrator shall calculate the unique WPAF for each test segment with an "R" rating based on the applicable "A", "R" and "T" ratings as follows:

WPAF =

$$\frac{\text{PAF (A) x test segment length rated "A"} + \text{PAF (R) x test segment length rated "R"} + \text{PAF (T) x test segment length rated "T"}}{\text{Total repaired test segment length}}$$

This WPAF shall be applied to determine the payment adjustment for the repaired test segments in that tender item.

410.10.02.03 Payment Adjustments for Pipe Sewers

Tender item payment adjustments shall be applied only to inspected pipe sewer tender items and associated repaired test segments within the highway section as identified on Form PH-CC-822PIC.

Tender item payment adjustments in the current construction season are not subject to any WPAF as may have been determined through the post installation inspection or a referee post installation inspection carried out in previous construction seasons for the same tender item.

To calculate the payment adjustment for an inspected tender item excluding the repaired test segments in the tender item, the following formula using the unique WPAF applicable to the tender item shall be used:

$$\text{Pay. Adjust.} = (\text{Quantity Installed} - \text{Repaired Test Segments Quantity}) \times \text{Contract Price} \times (\text{WPAF} - 1.00)$$

A payment adjustment shall be calculated separately for each tender item that had test segments inspected.

To calculate the payment adjustment for repaired test segments in a tender item, the following formula using the unique WPAF applicable to the repaired test segment shall be used:

$$\text{Pay. Adjust.} = \text{Repaired Test Segment Quantity} \times \text{Contract Price} \times (\text{WPAF} - 1.00)$$

A payment adjustment shall be calculated separately for each repaired test segment that has been assessed with a different WPAF or is from a different tender item. Repaired test segments shall be grouped only if they are from the same tender item and have the same WPAF.

When the payment adjustment is zero, there is no payment change. When the payment adjustment is negative, it is a payment reduction.

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 Accepted Repair Methods			
Repair Method Impact	Repair Method	Pipe Material Application	Repair Method Description
Non-intrusive	Epoxy injection	Concrete	Filling entire fracture with epoxy material to seal against leakage
	High pressure chemical grout	Concrete	Pumping chemical grout into entire fracture to fill the void(s) behind the pipe wall to preserve the structural integrity of the pipe and seal against leakage
	Patching	Concrete	Filling spalled or chipped pipe wall areas with concrete material to prevent early exposure of reinforcing steel bars
	Re-rounding	Steel, HDPE or PVC	Reinstating a flexible pipe to the accepted construction tolerance or Owner acceptance limits
Intrusive	Fold and form	Concrete	Placement of a length of softened pipe material into a pipe installation and expanding to “fit” the inner dimensions of the deficient pipe in order to seal against leakage and maintaining 90% of original flow area.
	Lining	Concrete	Insertion of a short length of smaller pipe into a larger gravity pipe installation and sealing the area between the pipes with grout to provide structural integrity and seal against leakage and maintaining 90% of original flow area.
	Internal sleeve	Concrete	Insertion of a complete smaller gravity pipe installation into a larger gravity pipe installation and sealing the area between the pipes with grout to provide structural integrity seal against leakage and maintaining 90% of original flow area.

Table 3 Gravity Pipe Codes and Associated Pipe Condition Status							
Pipe Condition Status Assessment		Threshold □	Repair ▣	Reject ■	Not Applicable -		
Pipe Condition Codes	Pipe Code Description and Attributes	Rigid Pipe Applications			Flexible Pipe Applications		
		Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)	Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)
B	Broken pipe has noticeable displacement of cracked pipe wall segments where the breaks show half the pipe wall thickness or greater for thick walled pipe or there is clear visible separation between pipe wall segments for thin (≤ 8.0 mm) walled pipe	■	■	■	■	■	■
CC	Circumferential crack is visible and apparent but crack edges are not visibly open and the crack spans more than 1 but less than 2 clock reference segments (i.e. between 1 to 3 o'clock)	□	□	□	-	-	-
	Circumferential crack is visible and apparent but crack edges are not visibly open and the crack spans 3 or more clock reference segments (i.e. greater than 1 to 4 o'clock)	■	■	■	-	-	-
	Circumferential crack is visible and apparent but crack edges are not visibly open	-	-	-	■	■	■
CL	Longitudinal crack is visible and apparent but crack edges are not visibly open and the crack is $\geq 1/3$ and $\leq 1/2$ of individual pipe length	□	□	□	-	-	-
	Longitudinal crack is visible and apparent but crack edges are not visibly open and the crack is $> 1/2$ of individual pipe length	■	■	■	-	-	-
	Longitudinal crack is visible and apparent but crack edges are not visibly open	-	-	-	■	■	■
CM	Multiple cracks (CC, CL and CS) are several cracks that are visible and apparent but crack edges are not visibly open	■	■	■	■	■	■

Table 3 Gravity Pipe Codes and Associated Pipe Condition Status							
Pipe Condition Status Assessment		Threshold □	Repair ◻	Reject ■	Not Applicable -		
Pipe Condition Codes	Pipe Code Description and Attributes	Rigid Pipe Applications			Flexible Pipe Applications		
		Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)	Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)
CS	Spiral crack is visible and apparent but crack edges are not visibly open and the crack is $\geq 1/3$ and $\leq 1/2$ of individual pipe length	□	□	□	-	-	-
	Spiral crack is visible and apparent but crack edges are not visibly open and the crack is $\geq 1/2$ of individual pipe length	■	■	■	-	-	-
	Spiral crack is visible and apparent but crack edges are not visibly open	-	-	-	■	■	■
FC	Circumferential fracture is a crack where the edges are visibly separated with an opening width that is ≤ 0.6 mm and is ≤ 1 clock reference segments (i.e. between 1 to 2 o'clock)	□	□	□	-	-	-
	Circumferential fracture is a crack where the edges are visibly separated with an opening width that is ≤ 0.6 mm and is > 1 and ≤ 2 clock reference segments (i.e. between 1 to 3 o'clock)	◻	◻	◻	-	-	-
	Circumferential fracture is a crack where the edges are visibly separated with an opening width that is ≤ 0.6 mm and is more than 2 clock reference segments (i.e. greater than 1 to 3 o'clock)	■	■	■	-	-	-
	Circumferential fracture is a crack where the edges are visibly separated with an opening width that is > 0.6 mm and > 1 and ≤ 2 clock reference segments (i.e. between 1 to 3 o'clock)	◻	◻	◻	-	-	-
	Circumferential fracture is a crack where the edges are visibly separated with an opening width that is > 0.6 mm and is more than 2 clock reference segments (i.e. greater than 1 to 3 o'clock)	■	■	■	-	-	-
	Circumferential fracture is a crack where the edges are visibly separated	-	-	-	■	■	■

Table 3 Gravity Pipe Codes and Associated Pipe Condition Status							
Pipe Condition Status Assessment		Threshold □	Repair ▣	Reject ■	Not Applicable -		
Pipe Condition Codes	Pipe Code Description and Attributes	Rigid Pipe Applications			Flexible Pipe Applications		
		Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)	Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)
FL	Longitudinal fracture is a crack where the edges are visibly separated with an opening width that is ≤ 0.6 mm and the crack is $\geq 1/3$ and $\leq 1/2$ of individual pipe length	□	□	□	-	-	-
	Longitudinal fracture is a crack where the edges are visibly separated with an opening width that is ≤ 0.6 mm and the crack is $> 1/2$ of individual pipe length	■	■	■	-	-	-
	Longitudinal fracture is a crack where the edges are visibly separated with an opening width that is > 0.6 mm and the crack is $\geq 1/3$ and $\leq 1/2$ of individual pipe length	▣	▣	▣	-	-	-
FL	Longitudinal fracture is a crack where the edges are visibly separated with an opening width that is > 0.6 mm and the crack is $> 1/2$ of individual pipe length	■	■	■	-	-	-
	Longitudinal fracture is a crack where the edges are visibly separated	-	-	-	■	■	■
FM	Multiple fracture (FC, FL and FS) are several cracks where the edges are visibly separated	■	■	■	■	■	■

Table 3 Gravity Pipe Codes and Associated Pipe Condition Status									
Pipe Condition Status Assessment		Threshold □	Repair ▣	Reject ■	Not Applicable -				
Pipe Condition Codes	Pipe Code Description and Attributes		Rigid Pipe Applications			Flexible Pipe Applications			
			Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)	Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)	
FS	Spiral fracture is a crack where the edges are visibly separated with an opening width that is ≤ 0.6 mm and the crack is $\geq 1/3$ and $\leq 1/2$ of individual pipe length		□	□	□	-	-	-	
	Spiral fracture is a crack where the edges are visibly separated with an opening width that is ≤ 0.6 mm and the crack is $> 1/2$ of individual pipe length		■	■	■	-	-	-	
	Spiral fracture is a crack where the edges are visibly separated with an opening width that is > 0.6 mm and the crack is $\geq 1/3$ and $\leq 1/2$ of individual pipe length		▣	▣	▣	-	-	-	
	Spiral fracture is a crack where the edges are visibly separated with an opening width that is > 0.6 mm and the crack is $> 1/2$ of individual pipe length		■	■	■	-	-	-	
	Spiral fracture is a crack where the edges are visibly separated		-	-	-	■	■	■	
H	Visible hole in the pipe sewer wall		■	■	■	■	■	■	
D	Deformed Pipe determined by visual techniques	right or left side only $> 5\%$ and ≥ 2 clock references (i.e. greater than 1 to 3 o'clock)	-	-	-	■	■	■	
		upper or lower left or right quadrants $> 5\%$ and ≥ 2 clock references (i.e. greater than 1 to 3 o'clock)	-	-	-	■	■	■	
D	Deformed Pipe determined by deflection measurements	≤ 750 mm	$> 5\%$ and $\leq 7.5\%$	-	-	-	□	□	□
			$> 7.5\%$ and $\leq 10\%$	-	-	-	▣	▣	▣
			$> 10\%$	-	-	-	■	■	■
		> 750 mm	$> 5\%$ and $\leq 7.5\%$	-	-	-	▣	▣	▣
			$> 7.5\%$	-	-	-	■	■	■

Table 3 Gravity Pipe Codes and Associated Pipe Condition Status							
Pipe Condition Status Assessment		Threshold ☐	Repair ☐	Reject ☒	Not Applicable -		
Pipe Condition Codes	Pipe Code Description and Attributes	Rigid Pipe Applications			Flexible Pipe Applications		
		Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)	Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)
DE	Settled deposits in the pipe blocking > 10% of cross sectional area, regardless of material composition	☐	☐	☐	☐	☐	☐
DI	Dropped invert of individual pipe lengths or at end of sewer run or culvert	☒	☒	☒	☒	☒	☒
JDM	Pipe lengths have slid apart at the joint with a separation distance between pipe length edges that is ≥ 50 mm and ≤ 75 mm, however, there is no opening where the pipe fill material is visible	☐	☐	☐	☐	☐	☐
JDL	Pipe lengths have slid apart at the joint with a separation distance between pipe length edges that is > 75 mm, however, there is no opening where the pipe fill material is visible	☒	☐	☐	☒	☐	☐
LL or LR	Line deviations left or right by > 5 and ≤ 10 degrees as applied to straight pipe run installations	☐	☐	☐	☐	☐	☐
	Line deviations left or right by > 10 degrees and ≤ 20 degrees as applied to straight pipe run installations	☐	☐	☐	☐	☐	☐
	Line deviations left or right by > 20 degrees as applied to straight pipe run installations	☒	☒	☒	☒	☒	☒
LD or LU	Line deviations up or down by > 5 and ≤ 10 degrees as applied to straight pipe run installations	☐	☐	☐	☐	☐	☐
	Line deviations up or down by > 10 degrees as applied to straight pipe run installations	☒	☒	☒	☒	☒	☒
OB	An obstruction is apparent in the pipe and is not a feature that has been built into or inserted into the pipe	☐	☐	☐	☐	☐	☐
OJM	Pipe lengths have slid apart at the joint displaying an opening where pipe fill material is visible and the opening width is ≥ 50 mm and ≤ 75 mm	☒	☐	☐	☒	☐	☐

Table 3
Gravity Pipe Codes and Associated Pipe Condition Status

Pipe Condition Status Assessment		Threshold ☐	Repair ☐	Reject ☒	Not Applicable -		
Pipe Condition Codes	Pipe Code Description and Attributes	Rigid Pipe Applications			Flexible Pipe Applications		
		Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)	Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)
OJL	Pipe lengths have slid apart at the joint displaying an opening where pipe fill material is visible and the opening width is > 75 mm	☒	☐	☐	☒	☐	☐
IS	Infiltration seeping is the slow ingress of water into the pipe through a fracture with crack width opening ≤ 0.6 mm but there are no visible drips	☐	☐	☐	☒	☒	☒
	Infiltration seeping is the slow ingress of water into the pipe through a fracture with crack width opening > 0.6 mm but there are no visible drips	☐	☐	☐	☒	☒	☒
	Infiltration seeping is the slow ingress of water into the pipe through a joint (JDM) but there are no visible drips	☒	☐	☐	☒	☐	☐
	Infiltration seeping is the slow ingress of water into the pipe through a joint (JDL) but there are no visible drips	☒	☐	☐	☒	☐	☐
ID	Infiltration dripping is water dripping into the pipe through a fracture with crack width opening ≤ 0.6 mm but not in a continuous flow	-	-	-	☒	☒	☒
	Infiltration dripping is water dripping into the pipe through a fracture with crack width opening > 0.6 mm but not in a continuous flow	☐	☐	☐	☒	☒	☒
	Infiltration dripping is water dripping into the pipe through a joint (JDM) but not in a continuous flow	☐	☐	☐	☐	☐	☐
ID	Infiltration dripping is water dripping into the pipe through a joint (JDL) but not in a continuous flow	☒	☐	☐	☒	☐	☐
IR	Infiltration running is water running into the pipe through a fracture with crack width opening ≤ 0.6 mm and a continuous flow is visible	☐	☐	☐	☒	☒	☒

Table 3 Gravity Pipe Codes and Associated Pipe Condition Status							
Pipe Condition Status Assessment		Threshold ☐	Repair ☐	Reject ☒	Not Applicable -		
Pipe Condition Codes	Pipe Code Description and Attributes	Rigid Pipe Applications			Flexible Pipe Applications		
		Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)	Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)
IR	Infiltration running is water running into the pipe through a joint and a continuous flow is visible	☐	☐	☐	☐	☐	☐
IG	Infiltration gushing is water entering the pipe through a fracture or joint under pressure but may not necessarily be a heavy flow	☒	☒	☒	☒	☒	☒
SWM	Surface Damage to pipe coating by abrasion, wear or other installation related damages on galvanized, aluminized Type II and/or polymer laminated steel pipes where the damage area's linear measurement is $\leq 10\%$ of individual pipe length and the damage area's widest width measurement is ≤ 2 clock segments (i.e. between 1 to 3 o'clock)	-	-	-	☐	☐	☐
SWL	Surface Damage to pipe coating damage by abrasion, wear or other installation related damages on galvanized, aluminized Type II and/or polymer laminated steel pipes where the damage area's linear measurement is $> 10\%$ of individual pipe length and the damage area's widest width measurement is > 2 clock segments (i.e. greater than 1 to 3 o'clock)	-	-	-	☒	☒	☒
SWM	Surface wear in the context of abrasion, wear or other installation related damages to the inner surface of HDPE and PVC pipe products where the damage area's linear measurement is $\leq 10\%$ of individual pipe length and the damage area's widest width measurement is ≤ 2 clock segments (i.e. between 1 to 3 o'clock)	-	-	-	☐	☐	☐
SWL	Surface wear in the context of abrasion, wear or other installation related damages to the inner surface of HDPE and PVC pipe products where the damage area's linear measurement is $> 10\%$ of individual pipe length and the damage area's widest width measurement is > 2 clock segments (i.e. greater than 1 to 3 o'clock)	-	-	-	☒	☒	☒

Table 3 Gravity Pipe Codes and Associated Pipe Condition Status							
Pipe Condition Status Assessment		Threshold ☐	Repair ☐	Reject ☒	Not Applicable -		
Pipe Condition Codes	Pipe Code Description and Attributes	Rigid Pipe Applications			Flexible Pipe Applications		
		Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)	Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)
SSM	Surface Damage in the context of spalling where inner surface is splintered or chipped where total area coverage is ≥ 0.5 and ≤ 1.0 m in length and ≤ 2 clock reference segments in width (i.e. between 1 to 3 o'clock)	☐	☐	☐	-	-	-
SSL	Surface Damage in the context of spalling where inner surface is splintered or chipped where total area coverage is > 1.0 m in length and > 2 clock reference segments in width (i.e. greater than 1 to 3 o'clock)	☒	☒	☒	-	-	-
SR	Sealing ring at the pipe joint is displaced and intruding into the pipe	☐	☐	☐	☐	☐	☐
SRB	Sealing ring at the pipe joint is broken	☐	☐	☐	☐	☐	☐
X	Collapsed Pipe $> 50\%$ of cross sectional area lost	☒	☒	☒	☒	☒	☒
JX	Pipe junction defective means that the junction is damaged or incorrectly positioned	☒	☒	☒	☒	☒	☒
CNI	Service Connection intruding means that the connection is jutting into the drainage structure	☐	☐	☐	☐	☐	☐
CX	Service Connection defective means that the connection is damaged or incorrectly positioned	☒	☒	☒	☒	☒	☒
CXI	Service Connection defective and intruding means that the connection is damaged or incorrectly positioned and is jutting into the drainage structure	☒	☒	☒	☒	☒	☒

*** Note:**

Gravity pipe sewer requirements are as specified in the Pipe Joints column of the Quantities – Sewers contract sheets. The requirements are:

S for soil tight (replaces N);
F for silt or fines tight (replaces L); and
L for water or leak tight (replaces H).

Pipe Condition Codes are the standard condition classification codes as identified in the Manual of Sewer Condition Classification.



Figure 1
CSA Standards
Certification Logo

Appendix 410-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

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR PIPE CULVERT INSTALLATION IN OPEN CUT

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APPENDICES

421-A	Commentary

421.01 SCOPE

This specification covers the requirements for the installation and inspection 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 provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

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 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.

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

CSA Standards

G401	Corrugated Steel Pipe Products

ASTM International

B 746	Corrugated Aluminum Alloy Structural Plate for Field-Bolted Pipe, Pipe-Arches, and Arches
C 507-12	Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe

Other

WRc Manual of Sewer Condition Classification (MSCC), Fourth and/or Third Edition

421.03 DEFINITIONS

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

Acceptable Pipe Condition Status means the assessment designation assigned to an installed gravity pipe installation that has no deficiencies.

Aluminum Alloy means a material made with two or more metals in which aluminum is the predominant metal.

Backfilling means the operation of filling the trench with bedding, cover, and backfill material or embedment and backfill material.

CCTV means closed-circuit television used to inspect a gravity pipe installation.

Certification Body means an independent 3rd party agency accredited by the Standards Council of Canada that has the qualifications, skills, and expertise required to confirm that a pipe manufacturer produces pipe products to the quality and requirements of an accepted standard and that has the mandate to certify the pipe products produced.

Certified means pipe products that have been marked with a certification body's logo confirming that the production of the pipe product is in accordance with the quality and requirements of the manufacturing standard.

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.

Delivered Quality means the pipe products' physical condition upon arrival at the construction site in terms of the extent and degree of dents, scratches, cracks, pipe coating integrity, etc., that appear on the pipe products delivered.

Direct Measurement means measuring pipe parameters such as diameters to determine deflections or the offsets/displacements at joints/service connections to determine pipe joint integrity in a gravity pipe installation using a measuring tape, pre-measured rod or other suitable measuring devices.

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, polyethylene, or steel pipe.

Gravity Pipe Installation means a constructed pipe system conveying surface waters under the influences of gravity only and can be a pipe sewer or a pipe culvert.

Inspection Assessment means evaluating the findings of a post installation inspection and quantifying the pipe condition status of the gravity pipe installation.

Laser Profiler means an instrument that uses a light ring to survey, locate, measure and report profile, deflection and dimensional attributes, including anomalies, in a gravity pipe installation.

Mandrel means an instrument equipped with an odd number of arms that is pulled through a flexible gravity pipe installation to determine deflection anomalies.

NASSCO means the National Association of Sewer Service Companies which certifies inspectors to perform inspection of pipe sewers and culverts and code viewed pipe conditions.

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 Condition Assessment Rating means the final gravity pipe installations' acceptance rating that is given to the pipe based on the evaluation of the final post installation inspection results inclusive of both original and additional test segments from the post installation inspection, referee post installation inspection and follow up repair inspection.

Pipe Condition Coding means the assignment of code designations to pipe attributes such as pipe materials, walls, joints, service connections or any other physical pipe characteristics.

Pipe Condition Status means the designation assigned to the gravity pipe installation based on the assessment of the post installation inspection results.

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.

Post Installation Inspection means quantifying the final installed condition of gravity pipe installations using accepted surveillance and measuring methods.

Reject Pipe Condition Status means the designation assigned to an installed gravity pipe installation, pipe lengths, pipe fittings and/or pipe service connections that have deficiencies that cannot be repaired to maintain the structural integrity or design service life of the gravity pipe installation or has certain measurable pipe attributes that are beyond Owner acceptance limits.

Repair Pipe Condition Status means the designation assigned to an installed gravity pipe installation, pipe lengths, pipe fittings and/or pipe service connections that have deficiencies that can be repaired to maintain the structural integrity and design service life of the gravity pipe installation.

Repaired Pipe Condition Status means the designation assigned to installed gravity pipe installations, pipe lengths, pipe fittings and/or pipe service connections with a Repair Pipe Condition Status that have been repaired using acceptable intrusive repair measures.

Replacing means the removal of any gravity pipe installations, pipe lengths, pipe fittings and/or pipe service connections and reinstalling the gravity pipe installation, pipe lengths, pipe fittings and/or pipe service connections to contract specifications.

Threshold Pipe Condition Status is the designation assigned to an installed gravity pipe installation, pipe lengths, pipe fittings and/or pipe service connections that have certain measurable pipe attributes that are beyond accepted construction limitations but are still within Owner acceptance limits and requires no remediation actions.

Test Segment means an individual sewer pipe run or pipe culvert that has been selected to have a post installation inspection performed on it.

Visual Observation Inspection means coding and describing the profiles, deflection and dimensional features, including anomalies, in a gravity pipe installation using direct human entry into the pipe sewer run or pipe culvert.

Zoom Camera means a stationary video camera fitted with a tele-objective zoom lens and high-powered floodlights and used to inspect a gravity pipe installation.

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.

Steel structural plate pipe with polymer coating shall be according to CSA G401.

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.

421.05.01.07 Aluminum Alloy Pipe Products

Corrugated aluminum alloy structural plate pipe products shall be according to ASTM B746.

All corrugated aluminum alloy structural plate pipe products used on the Contract shall be certified and supplied from a manufacturer that produces the corrugated aluminum alloy structural plate pipe products according to ASTM B746. Only products with an accepted certification body logo marking as shown in Figure 1 shall be used.

Inspection, testing, and record keeping for corrugated aluminum alloy structural plate pipe products shall be according to ASTM B746.

Certified corrugated aluminum alloy structural plate pipe shall be marked according to ASTM B746, and shall include as a minimum the logo of the certification body and name of the pipe manufacturer.

When requested by the Owner, a copy of the certificate of compliance issued by the certification body confirming that the manufacturer produces certified corrugated aluminum alloy structural plate pipe products shall be submitted to the Contract Administrator.

The cost of all testing, except that performed in the Owner's laboratory, shall be included in the price. Where the delivered quality of certified corrugated aluminum alloy structural plate pipe products is deemed to be unacceptable by the Contract Administrator, the products shall be rejected.

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 up grade.

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
- g) Mechanical Restrained Joint with Gasket

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.

421.07.12.08 Corrugated Aluminum Alloy Structural Plate Pipe

Corrugated aluminum alloy structural plate pipe shall be jointed by means of bolts as recommended by the manufacturer to satisfy the pipe joint specification.

421.07.13 Post Installation Inspection

The post installation inspection of pipe culverts shall be carried out by the Contract Administrator as specified in the Quality Assurance section under the following conditions:

- a) When the total combined pipe sewer length of all pipe sewer tender items is greater than or equal to 500 m; or
- b) If the total pipe sewer length of all pipe sewer tender items is less than 500 m, when at least one sewer pipe run will be constructed with a pipe diameter greater than or equal to 450 mm and is greater than or equal to 50 m in length.

A competent and authorized representative of the Contractor, by completing Form PH-CC-822PIC (Culvert Section), shall certify that all pipe culvert installations, within the highway section identified, have been installed and completed in general conformance with the Contract Documents and are ready for the post installation inspection. Submission of Form PH-CC-822PIC shall be deemed to be the request to the Contract Administrator to have the post installation inspection performed at the certification stage indicated on the form. A separate Form PH-CC-822PIC shall be submitted for each construction season of the Contract to have the post installation inspection apportioned by construction season.

The Contract Administrator, upon approving the request, within five Business Days of receipt of Form PH-CC-822PIC, shall provide notification of the start date of the post installation inspection.

Upon commencement of the post installation inspection, the Contractor shall ensure that construction work shall be discontinued temporarily in the vicinity of a pipe culvert being inspected until the inspection of that pipe culvert has been completed.

421.07.14 Cleaning and Flushing of Pipe Culverts

At least two Business Days prior to the commencement of the post installation inspection, the pipe culverts shall be prepared for inspection by cleaning and flushing. The material from the cleaning and flushing operation shall be managed as specified elsewhere in the Contract.

421.07.15 Clay Seals

Clay seals 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.

421.08 QUALITY ASSURANCE

421.08.01 Acceptance

Acceptance shall be according to this specification, including satisfactory completion of all replacement and remedial actions associated with identified deficiencies.

421.08.02 Post Installation Inspection Procedures

Notwithstanding that inspection for compliance with the Contract Documents will be performed during the Contractor's installation of the pipe culverts, the Contract Administrator shall carry out the post installation inspection on a number of test segments. The number of test segments inspected will account for a minimum of 25% of the total number of pipe culvert installations on the Contract for the purpose of defining the quality of workmanship and acceptability of the pipe culvert installations.

On contracts with less than four pipe culverts, a minimum of one test segment will be inspected.

Selected test segments constructed with rigid pipe materials will be inspected using CCTV, zoom camera or by visual observations. Selected test segments constructed with flexible pipe materials will be inspected using CCTV, zoom camera or by visual observations and shall also be inspected for deflection using a mandrel, laser profiler or by direct measurement.

The Contract Administrator shall randomly select the test segments to be inspected on the Contract. If inspecting in a construction season, the number of test segments selected shall be apportioned across all construction seasons to comprise the total amount of test segments to be inspected.

Selected test segments shall be inspected throughout their entire length.

All CCTV, zoom camera or visual observation operations for the post installation inspection will be performed by a certified NASSCO inspector. The certified NASSCO inspector will be responsible to carry out all mandrel, laser profiling or direct measurement operations on flexible pipe culvert installations.

The Contractor may be present during the inspection operations.

Pipe culverts that are to be installed in a preloaded or surcharged condition as specified in the Contract Documents will not be selected as a test segment and will not be subject to payment adjustments. However, these pipe culverts may be subject to a post installation inspection should poor performance and/or service arise after installation. Upon assessment of the post installation inspection submission, any repair or replacement issues shall be dealt with on a case by case basis.

421.08.03 Post Installation Inspection Assessments

The Contract Administrator will assess the post installation inspection submissions for each test segment inspected quantifying the pipe condition statuses as per the pipe condition codes shown in Table 2.

Within 20 Business Days of receipt of Form PH-CC-822PIC, the Contract Administrator shall, for all test segments inspected, provide the Contractor, with copies of all test segment post installation inspection submissions and assessments. This will serve as notification to the Contractor if further action, based on the test segments' pipe condition statuses, is required.

421.08.04 Replacement and Repair

421.08.04.01 Replacement

All individual pipe lengths and/or joints in a test segment assessed with a "Reject" Pipe Condition status shall be replaced by the Contractor by installing new pipe lengths, service connections and/or joints as required.

The Contract Administrator shall, upon written notification from the Contractor that replacement operations have been completed, perform a replacement post installation inspection of all test segments where pipe lengths and/or joints have been replaced and will assess the test segments' pipe condition statuses based on the replacement post installation inspection.

421.08.04.02 Repair

All individual pipe lengths and/or joints in a test segment assessed with a "Repair" Pipe Condition status shall be repaired by the Contractor.

Table 1 lists Owner accepted repair methods and pipe material application that may be used.

The Contractor shall submit a repair proposal to the Contract Administrator within five Business Days after receipt of the test segments' post installation inspection submissions and assessments. The Contract Administrator will review the repair proposal within three Business Days.

Upon approval by the Contract Administrator, the Contractor shall carry out the repairs of the pipe lengths and/or joints in the test segments in accordance with the approved repair proposal.

All repair methods, measures and materials used shall be documented.

The Contract Administrator shall, upon written notification from the Contractor that repair operations have been completed, perform a follow up repair inspection on the pipe lengths and/or joints in the test segments that have been repaired to confirm that the repairs have been made by the Contractor as approved.

Notwithstanding where a test segment or portion of the test segment has been assessed by the Contract Administrator with a "Repair" Pipe Condition status and upon attempting to implement the approved repair proposal, the Contractor determines that the proposed repair measures cannot repair the test segment or portion of the test segment; the test segment or portion of the test segment shall be replaced by the Contractor.

The Contract Administrator shall, upon written notification from the Contractor that replacement operations have been completed, perform a replacement post installation inspection of the test segment in its entirety upon completion of the replacement of the test segment or portion of the test segment and will assess the test segments' pipe condition statuses based on the replacement post installation inspection.

421.08.05 Acceptance

A pipe culvert tender item shall be accepted based on the post installation inspection assessment of selected test segments for that pipe culvert tender item. Additional test segments shall be added as described elsewhere in this specification.

Inspected test segments shall be accepted or not accepted as follows:

Individual test segments or portions of a test segment and/or the joints in a test segment that received no Pipe Condition Code are assessed with an Acceptable Pipe Condition rating, and are not subject to price adjustment.

Individual test segments or portions of a test segment and/or the joints in a test segment that received a Repair Pipe Condition rating, and where the Contract Administrator has confirmed that the Contractor has performed the repairs using non-intrusive repair methods, are deemed acceptable and shall be upgraded to a final Acceptable Pipe Condition rating, and as such are not subject to a price adjustment.

If there are more than 2 repair deficiencies per linear metre or a common repair deficiency is found on 15% or more of the pipe lengths or joints in the test segments inspected where non-intrusive repair measures were used to perform the repairs, the Contract Administrator shall randomly select, at a minimum, an equivalent amount of additional test segments for the post installation inspection.

Individual test segments or portions of a test segment and/or the joints in a test segment that received a Threshold Pipe Condition rating are acceptable, however, are subject to a price adjustment.

If there are more than 2 threshold deficiencies per linear metre or a common threshold deficiency is found on 25% or more of the pipe lengths and/or joints in the test segments inspected, the Contract Administrator shall randomly select, at a minimum, an equivalent amount of additional test segments for the post installation inspection.

Individual test segments or portions of a test segment and/or the joints in a test segment that received a Repair Pipe Condition rating, and where the Contract Administrator has confirmed that the Contractor has performed the repairs using intrusive repair methods, are deemed to be adequate and the entire test segment shall be upgraded to a final Repaired Pipe Condition rating, however, is subject to a price adjustment.

If repair deficiencies were found and intrusive measures were used to repair an individual test segment or portions of test segments, the Contract Administrator shall randomly select, at a minimum, an equivalent amount of additional test segments for the post installation inspection.

Individual test segments or portions of a test segment and/or joints in a test segment that received a Reject Pipe Condition rating are not acceptable.

Of the individual test segments or portions of a test segment and/or the joints in the test segments inspected, if 10% or more of the test segments and/or joints received a Reject Pipe Condition rating, the Contract Administrator shall randomly select, at a minimum, an equivalent amount of additional test segments for the post installation inspection.

421.08.06 Referee Testing

The Contractor may request referee testing on individual test segments or portions of a test segment that received a "Repair", "Reject" or "Threshold" Pipe Condition Status.

Referee testing may only be invoked within five Business Days of the Contractor receiving copies of the test segments' post installation inspection submissions and assessments.

Referee testing shall be done through the following procedure:

- a) The Contractor shall identify the assessments of individual test segments or portions of any test segments that they disagree with;
- b) The Contract Administrator shall arrange for a referee post installation inspection to be performed by an independent NASSCO certified, third party inspector using the same inspection criteria, type of

equipment and techniques as was used for the original post installation inspection on the test segments under disagreement;

- c) The Contract Administrator shall assess the referee post installation inspection submission, which replaces the original post installation inspection submission, for each test segment or portions of test segments under disagreement which will then be binding on both parties; and
- d) The Contract Administrator will provide the Contractor with copies of the test segment referee post installation inspection submissions and assessments which will serve as notification to the Contractor if further action, based on the pipe condition statuses, is required.

421.08.07 Final Pipe Condition Assessment Rating

The Contract Administrator shall assign final Pipe Condition Assessment Ratings (PCAR) as follows:

A PCAR of "R" is assigned to those test segments that, either in part or in whole, initially received a Repair Pipe Condition Status and have been upgraded to a Repaired Pipe Condition Status;

and for the remaining test segments:

A PCAR of "A" is assigned to the portion of the remaining test segments length that received an Acceptable Pipe Condition Status; and

A PCAR of "T" is assigned to the portion of the remaining test segments length that received a Threshold Pipe Condition Status.

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 or pipe end section to the other end of the pipe or the other pipe end section. 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

Payment at the Contract price for the above tender items shall be full compensation for all Labour, Equipment, and Material to do the work, subject to the payment adjustments as specified in this specification.

Costs for the replacement and/or repair of test segments including but not limited to the associated costs for the reinstatement of the highway structure and all ancillary features previously constructed above the test segments shall be at the Contractor's expense at no additional cost to the Owner. Costs for any delays associated with the repair and/or replacement of the test segments and the reinstatement of the highway structure and all ancillary features previously constructed above the test segments shall also be at the Contractor's expense.

The cost of traffic control for the post installation inspection shall be at the Contractor's expense at no additional cost to the Owner.

The cost for inspection of additional test segments in the post installation inspection, follow up repair inspection and/or replacement post installation inspection, including traffic control, according to the Acceptance of Pipe Culverts clause shall be at the Contractor's expense at no additional cost to the Owner.

The cost of referee post installation inspection according to the Referee Testing clause shall:

- a) Where the assessment of the referee post installation inspection confirms the original pipe condition status, be borne by the Contractor; or
- b) Where the assessment of the referee post installation inspection upgrades the original pipe condition status, be borne by the Owner; or
- c) Where the assessment of the referee post installation inspection upgrades a portion of the original pipe condition status, be apportioned between the Contractor and the Owner based on the final upgraded and confirmed pipe proportions respectively.

421.10.02**Price Adjustment Factors**

Price Adjustment Factors (PAF) for each PCAR is noted as follows:

PCAR of "A" is subject to a PAF equal to 1;

PCAR of "R" is subject to a PAF equal to 0.75; and

PCAR of "T" is subject to a PAF equal to 0.85.

421.10.02.01**Application to Pipe Culvert Tender Items**

A Weighted Price Adjustment Factor (WPAF) is calculated for each pipe culvert tender item that had test segments inspected and is applied against that pipe culvert tender item only. Each pipe culvert tender item that had test segments inspected will have a unique WPAF.

Any test segments with a PCAR of "R" are price adjusted separately as described in Application to Repaired Test Segments clause.

The WPAF for a pipe culvert tender item is calculated using the total pipe length of those remaining test segments that have PCAR of "A" and "T" only.

The Contract Administrator shall calculate the WPAF for a pipe culvert tender item based on the "A" and "T" portions of the remaining test segments lengths, as follows:

WPAF =

$$\frac{\text{PAF(A)} \times \text{"A" portion of remaining test segments' length} + \text{PAF(T)} \times \text{"T" portion of remaining test segments' length}}{\text{Total pipe length of remaining test segments}}$$

This WPAF shall be applied to determine the payment adjustment for the tender item quantity minus the total quantity of test segments in that tender item that have a PCAR of "R".

421.10.02.02 Application to Repaired Test Segments

This individual WPAF is applied to all test segments that are rated "R". A separate WPAF is calculated for each test segment that is rated "R" within a pipe culvert tender item.

The Contract Administrator shall calculate the unique WPAF for each test segment with an "R" rating based on the applicable "A", "R" and "T" ratings as follows:

WPAF =

$$\frac{\text{PAF (A)} \times \text{test segment length rated "A"} + \text{PAF (R)} \times \text{test segment length rated "R"} + \text{PAF (T)} \times \text{test segment length rated "T"}}{\text{Total repaired test segment length}}$$

This WPAF shall be applied to determine the payment adjustment for the repaired test segments in that tender item.

421.10.02.03 Payment Adjustment for Pipe Culverts

Tender item payment adjustments shall be applied only to inspected pipe culvert tender items and associated repaired test segments within the highway section as identified on Form PH-CC-822PIC.

Tender item payment adjustments in the current construction season are not subject to any WPAF as may have been determined through the post installation inspection portion or a referee post installation inspection from previous construction seasons for the same tender item.

To calculate the payment adjustment for an inspected tender item excluding the repaired test segments in the tender item, the following formula using the unique WPAF applicable to the tender item shall be used:

$$\text{Pay. Adjust.} = (\text{Quantity Installed} - \text{Repaired Test Segments Quantity}) \times \text{Contract Price} \times (\text{WPAF} - 1.00)$$

A payment adjustment shall be calculated separately for each tender item that had test segments inspected.

To calculate the payment adjustment for repaired test segments in a tender item, the following formula using the unique WPAF applicable to the repaired test segment shall be used:

$$\text{Pay. Adjust.} = \text{Repaired Test Segment Quantity} \times \text{Contract Price} \times (\text{WPAF} - 1.00)$$

A payment adjustment shall be calculated separately for each repaired test segment that has been assessed with a different WPAF or is from a different tender item. Repaired test segments will be grouped only if they are from the same tender item and have the same WPAF.

When the payment adjustment is zero, there is no payment change. When the payment adjustment is negative, it is a payment reduction.

**Table 1
Accepted Repair Methods**

Repair Method Impact	Repair Method	Pipe Material Application	Repair Method Description
Non-intrusive	Epoxy injection	Concrete	Filling entire fracture with epoxy material to seal against leakage
	High pressure chemical grout	Concrete	Pumping chemical grout into entire fracture to fill the void(s) behind the pipe wall to preserve the structural integrity of the pipe and seal against leakage
	Patching	Concrete	Filling spalled or chipped pipe wall areas with concrete material to prevent early exposure of reinforcing steel bars
	Re-rounding	Steel, HDPE or PVC	Reinstating a flexible pipe to the accepted construction tolerance or Owner acceptance limits
Intrusive	Fold and form	Concrete	Placement of a length of softened pipe material into a pipe installation and expanding to "fit" the inner dimensions of the deficient pipe in order to seal against leakage and maintaining 90% of original flow area.
	Lining	Concrete	Insertion of a short length of smaller pipe into a larger gravity pipe installation and sealing the area between the pipes with grout to provide structural integrity and seal against leakage and maintaining 90% of original flow area.
	Internal sleeve	Concrete	Insertion of a complete smaller gravity pipe installation into a larger gravity pipe installation and sealing the area between the pipes with grout to provide structural integrity seal against leakage and maintaining 90% of original flow area.

Table 2
Gravity Pipe Codes and Associated Pipe Condition Status

Pipe Condition Status Assessment		Threshold □	Repair ■	Reject ■	Not Applicable -		
Pipe Condition Codes	Pipe Code Description and Attributes	Rigid Pipe Applications			Flexible Pipe Applications		
		Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)	Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)
B	Broken pipe has noticeable displacement of cracked pipe wall segments where the breaks show half the pipe wall thickness or greater for thick walled pipe or there is clear visible separation between pipe wall segments for thin (< 8.0 mm) walled pipe	■	■	■	■	■	■
CC	Circumferential crack is visible and apparent but crack edges are not visibly open and the crack spans more than 1 but less than 2 clock reference segments (i.e. between 1 to 3 o'clock)	□	□	□	-	-	-
	Circumferential crack is visible and apparent but crack edges are not visibly open and the crack spans 3 or more clock reference segments (i.e. greater than 1 to 4 o'clock)	■	■	■	-	-	-
	Circumferential crack is visible and apparent but crack edges are not visibly open	-	-	-	■	■	■
CL	Longitudinal crack is visible and apparent but crack edges are not visibly open and the crack is > 1/3 and < 1/2 of individual pipe length	□	□	□	-	-	-
	Longitudinal crack is visible and apparent but crack edges are not visibly open and the crack is > 1/2 of individual pipe length	■	■	■	-	-	-
	Longitudinal crack is visible and apparent but crack edges are not visibly open	-	-	-	■	■	■
CM	Multiple cracks (CC, CL and CS) are several cracks that are visible and apparent but crack edges are not visibly open	■	■	■	■	■	■

Table 2 Gravity Pipe Codes and Associated Pipe Condition Status							
Pipe Condition Status Assessment		Threshold □	Repair □	Reject ■	Not Applicable -		
Pipe Condition Codes	Pipe Code Description and Attributes	Rigid Pipe Applications			Flexible Pipe Applications		
		Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)	Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)
CS	Spiral crack is visible and apparent but crack edges are not visibly open and the crack is > 1/3 and < 1/2 of individual pipe length	□	□	□	-	-	-
	Spiral crack is visible and apparent but crack edges are not visibly open and the crack is > 1/2 of individual pipe length	■	■	■	-	-	-
CS	Spiral crack is visible and apparent but crack edges are not visibly open	-	-	-	■	■	■
FC	Circumferential fracture is a crack where the edges are visibly separated with an opening width that is < 0.6 mm and is < 1 clock reference segments (i.e. between 1 to 2 o'clock)	□	□	□	-	-	-
	Circumferential fracture is a crack where the edges are visibly separated with an opening width that is < 0.6 mm and is > 1 and < 2 clock reference segments (i.e. between 1 to 3 o'clock)	▣	▣	▣	-	-	-
	Circumferential fracture is a crack where the edges are visibly separated with an opening width that is < 0.6 mm and is more than 2 clock reference segments (i.e. greater than 1 to 3 o'clock)	■	■	■	-	-	-
	Circumferential fracture is a crack where the edges are visibly separated with an opening width that is > 0.6 mm and > 1 and < 2 clock reference segments (i.e. between 1 to 3 o'clock)	▣	▣	▣	-	-	-
	Circumferential fracture is a crack where the edges are visibly separated with an opening width that is > 0.6 mm and is more than 2 clock reference segments (i.e. greater than 1 to 3 o'clock)	■	■	■	-	-	-
	Circumferential fracture is a crack where the edges are visibly separated	-	-	-	■	■	■

Table 2 Gravity Pipe Codes and Associated Pipe Condition Status							
Pipe Condition Status Assessment		Threshold □	Repair ◻	Reject ■	Not Applicable -		
Pipe Condition Codes	Pipe Code Description and Attributes	Rigid Pipe Applications			Flexible Pipe Applications		
		Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)	Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)
FL	Longitudinal fracture is a crack where the edges are visibly separated with an opening width that is < 0.6 mm and the crack is > 1/3 and < 1/2 of individual pipe length	□	□	□	-	-	-
	Longitudinal fracture is a crack where the edges are visibly separated with an opening width that is < 0.6 mm and the crack is > 1/2 of individual pipe length	■	■	■	-	-	-
	Longitudinal fracture is a crack where the edges are visibly separated with an opening width that is > 0.6 mm and the crack is > 1/3 and < 1/2 of individual pipe length	◻	◻	◻	-	-	-
FL	Longitudinal fracture is a crack where the edges are visibly separated with an opening width that is > 0.6 mm and the crack is > 1/2 of individual pipe length	■	■	■	-	-	-
	Longitudinal fracture is a crack where the edges are visibly separated	-	-	-	■	■	■
FM	Multiple fracture (FC, FL and FS) are several cracks where the edges are visibly separated	■	■	■	■	■	■

Table 2 Gravity Pipe Codes and Associated Pipe Condition Status									
Pipe Condition Status Assessment		Threshold □	Repair ▣	Reject ■	Not Applicable -				
Pipe Condition Codes	Pipe Code Description and Attributes			Rigid Pipe Applications			Flexible Pipe Applications		
				Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)	Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)
FS	Spiral fracture is a crack where the edges are visibly separated with an opening width that is < 0.6 mm and the crack is > 1/3 and < 1/2 of individual pipe length			□	□	□	-	-	-
	Spiral fracture is a crack where the edges are visibly separated with an opening width that is < 0.6 mm and the crack is > 1/2 of individual pipe length			■	■	■	-	-	-
	Spiral fracture is a crack where the edges are visibly separated with an opening width that is > 0.6 mm and the crack is > 1/3 and < 1/2 of individual pipe length			▣	▣	▣	-	-	-
	Spiral fracture is a crack where the edges are visibly separated with an opening width that is > 0.6 mm and the crack is > 1/2 of individual pipe length			■	■	■	-	-	-
	Spiral fracture is a crack where the edges are visibly separated			-	-	-	■	■	■
H	Visible hole in the pipe sewer wall			■	■	■	■	■	■
D	Deformed Pipe determined by Visual techniques	right or left side only > 5% and > 2 clock references (i.e. greater than 1 to 3 o'clock)		-	-	-	■	■	■
		upper or lower left or right quadrants > 5% and > 2 clock references (i.e. greater than 1 to 3 o'clock)		-	-	-	■	■	■
D	Deformed Pipe determined by deflection measurements	< 750 mm	> 5% and < 7.5%	-	-	-	□	□	□
			> 7.5% and < 10%	-	-	-	▣	▣	▣
			> 10%	-	-	-	■	■	■
		> 750 mm	> 5% and < 7.5%	-	-	-	▣	▣	▣
			> 7.5%	-	-	-	■	■	■
				-	-	-	■	■	■

Table 2 Gravity Pipe Codes and Associated Pipe Condition Status							
Pipe Condition Status Assessment		Threshold ☐	Repair ☐	Reject ☒	Not Applicable -		
Pipe Condition Codes	Pipe Code Description and Attributes	Rigid Pipe Applications			Flexible Pipe Applications		
		Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)	Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)
DE	Settled deposits in the pipe blocking > 10% of cross sectional area, regardless of material composition	☐	☐	☐	☐	☐	☐
DI	Dropped invert of individual pipe lengths or at end of sewer run or culvert	☒	☒	☒	☒	☒	☒
JDM	Pipe lengths have slid apart at the joint with a separation distance between pipe length edges that is > 50 mm and < 75 mm, however, there is no opening where the pipe fill material is visible	☐	☐	☐	☐	☐	☐
JDL	Pipe lengths have slid apart at the joint with a separation distance between pipe length edges that is > 75 mm, however, there is no opening where the pipe fill material is visible	☒	☐	☐	☒	☐	☐
LL or LR	Line deviations left or right by > 5 and < 10 degrees as applied to straight pipe culvert installations	☐	☐	☐	☐	☐	☐
	Line deviations left or right by > 10 degrees and < 20 degrees as applied to straight pipe culvert installations	☐	☐	☐	☐	☐	☐
	Line deviations left or right by > 20 degrees as applied to straight pipe culvert installations	☒	☒	☒	☒	☒	☒
LD or LU	Line deviations up or down by > 5 and < 10 degrees as applied to straight pipe culvert installations	☐	☐	☐	☐	☐	☐
	Line deviations up or down by > 10 degrees as applied to straight pipe culvert installations	☒	☒	☒	☒	☒	☒
OB	An obstruction is apparent in the pipe and is not a feature that has been built into or inserted into the pipe	☐	☐	☐	☐	☐	☐
OJM	Pipe lengths have slid apart at the joint displaying an opening where pipe fill material is visible and the opening width is > 50 mm and < 75 mm	☒	☐	☐	☒	☐	☐

Table 2 Gravity Pipe Codes and Associated Pipe Condition Status							
Pipe Condition Status Assessment		Threshold ☐	Repair ☐	Reject ☒	Not Applicable -		
Pipe Condition Codes	Pipe Code Description and Attributes	Rigid Pipe Applications			Flexible Pipe Applications		
		Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)	Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)
OJL	Pipe lengths have slid apart at the joint displaying an opening where pipe fill material is visible and the opening width is > 75 mm	☒	☐	☐	☒	☐	☐
IS	Infiltration seeping is the slow ingress of water into the pipe through a fracture with crack width opening < 0.6 mm but there are no visible drips	☐	☐	☐	☒	☒	☒
IS	Infiltration seeping is the slow ingress of water into the pipe through a fracture with crack width opening > 0.6 mm but there are no visible drips	☐	☐	☐	☒	☒	☒
	Infiltration seeping is the slow ingress of water into the pipe through a joint (JDM) but there are no visible drips	☒	☐	☐	☒	☐	☐
	Infiltration seeping is the slow ingress of water into the pipe through a joint (JDL) but there are no visible drips	☒	☐	☐	☒	☐	☐
ID	Infiltration dripping is water dripping into the pipe through a fracture with crack width opening < 0.6 mm but not in a continuous flow	-	-	-	☒	☒	☒
	Infiltration dripping is water dripping into the pipe through a fracture with crack width opening > 0.6 mm but not in a continuous flow	☐	☐	☐	☒	☒	☒
ID	Infiltration dripping is water dripping into the pipe through a joint (JDM) but not in a continuous flow	☐	☐	☐	☐	☐	☐
	Infiltration dripping is water dripping into the pipe through a joint (JDL) but not in a continuous flow	☒	☐	☐	☒	☐	☐

Table 2 Gravity Pipe Codes and Associated Pipe Condition Status							
Pipe Condition Status Assessment		Threshold ☐	Repair ☐	Reject ☒	Not Applicable -		
Pipe Condition Codes	Pipe Code Description and Attributes	Rigid Pipe Applications			Flexible Pipe Applications		
		Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)	Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)
IR	Infiltration running is water running into the pipe through a fracture with crack width opening < 0.6 mm and a continuous flow is visible	☐	☐	☐	☒	☒	☒
	Infiltration running is water running into the pipe through a joint and a continuous flow is visible	☐	☐	☐	☐	☐	☐
IG	Infiltration gushing is water entering the pipe through a fracture or joint under pressure but may not necessarily be a heavy flow	☒	☒	☒	☒	☒	☒
SWM	Surface Damage to pipe coating by abrasion, wear or other installation related damages on galvanized, aluminized Type II and/or polymer laminated steel pipes where the damage area's linear measurement is < 10% of individual pipe length and the damage area's widest width measurement is < 2 clock segments (i.e. between 1 to 3 o'clock)	-	-	-	☐	☐	☐
SWL	Surface Damage to pipe coating damage by abrasion, wear or other installation related damages on galvanized, aluminized Type II and/or polymer laminated steel pipes where the damage area's linear measurement is > 10% of individual pipe length and the damage area's widest width measurement is > 2 clock segments (i.e. greater than 1 to 3 o'clock)	-	-	-	☒	☒	☒
SWM	Surface wear in the context of abrasion, wear or other installation related damages to the inner surface of HDPE and PVC pipe products where the damage area's linear measurement is < 10% of individual pipe length and the damage area's widest width measurement is < 2 clock segments (i.e. between 1 to 3 o'clock)	-	-	-	☐	☐	☐

Table 2 Gravity Pipe Codes and Associated Pipe Condition Status							
Pipe Condition Status Assessment		Threshold □	Repair □	Reject ■	Not Applicable -		
Pipe Condition Codes	Pipe Code Description and Attributes	Rigid Pipe Applications			Flexible Pipe Applications		
		Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)	Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)
SWL	Surface wear in the context of abrasion, wear or other installation related damages to the inner surface of HDPE and PVC pipe products where the damage area's linear measurement is > 10% of individual pipe length and the damage area's widest width measurement is > 2 clock segments (i.e. greater than 1 to 3 o'clock)	-	-	-	■	■	■
SSM	Surface Damage in the context of spalling where inner surface is splintered or chipped where total area coverage is > 0.5 and < 1.0 m in length and < 2 clock reference segments in width (i.e. between 1 to 3 o'clock)	■	■	■	-	-	-
SSL	Surface Damage in the context of spalling where inner surface is splintered or chipped where total area coverage is > 1.0 m in length and > 2 clock reference segments in width (i.e. greater than 1 to 3 o'clock)	■	■	■	-	-	-
SR	Sealing ring at the pipe joint is displaced and intruding into the pipe	■	■	□	■	■	□
SRB	Sealing ring at the pipe joint is broken	■	■	□	■	■	□
X	Collapsed Pipe > 50% of cross sectional area lost	■	■	■	■	■	■

*** Note:**

Gravity pipe culvert requirements are as specified in the Pipe Joints column of the Quantities – Pipe Culverts contract sheets. The requirements are:

S for soil tight (replaces N);
F for silt or fines tight (replaces L); and
L for water or leak tight (replaces H).

Pipe Condition Codes are the standard condition classification codes as identified in the Manual of Sewer Condition Classification.



FIGURE 1
CSA Standards
Certification Logo

Appendix 421-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

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR COMPACTING

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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 provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

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 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.

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

MTO Forms:
PH-CC-009 Field Compaction Report

ASTM International

D 6938-10 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 field tests indicate 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.

Field density and field moisture determinations shall be made according to ASTM D 6938.

501.07.04.02 Compaction Requirements

501.07.04.02.01 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.

501.07.04.02.02 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 MTO form PH-CC-009. 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 2 Business Days following the completion of a lot.

501.07.04.02.03 Test Equipment and Operator Training

501.07.04.02.03.01 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.

501.07.04.02.03.02 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.

501.07.04.02.03.03 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 subplot 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.

501.07.04.02.04 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 materials or both.
 - iii. At least once per calendar year on all carry-over Contracts.
- b) For earth, 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, 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 target density shall be established by the construction of a control strip according to the Control Strip clause.

When a control strip cannot be reasonably constructed or is impractical, with the consent of the Contract Administrator, the 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. In this case, the MDD used for the new target density shall be based on the average of all individual MDD's calculated from a minimum of 3 independent samples selected from materials to be used in the Work.

501.07.04.02.04.01 Control Strip

Prior to construction of a control strip, the Contractor shall:

- a) Give a minimum notice of 24 hours to the Contract Administrator.
- b) Determine the optimum moisture content (OMC) according to LS-706.

Each control strip shall consist of a single uniform lift not more than 0.30 m in depth and covering at least 400 m² in area.

During construction of the control strip, the average field moisture content shall be maintained within the range of no less than 2.0% lower than and no more than 1.0% greater than the OMC of the control strip material.

After initial placement of the material, the compaction equipment for that operation shall make 6 passes over the entire surface of the control strip. The field wet density and field moisture content shall be determined at a minimum of 3 randomly selected locations. The dry density shall be calculated for each of these locations and the average dry density and moisture content values used as the initial values for dry density and moisture content.

The compaction equipment shall then make 2 additional passes over the entire surface of the control strip.

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.

A minimum of 3 separate random field density and moisture content determinations shall then be made and a new average dry density and moisture content shall be calculated.

If the new average dry density exceeds the previous value by more than 0.030 t/m^3 , 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/m^3 , the compaction of the control strip shall be considered satisfactory and complete.

Upon satisfactory completion of the control strip, an additional 7 field wet density and moisture content tests shall be taken at random locations and the dry density and moisture content values determined. The final dry density and moisture content of the control strip shall be the average of these 7 values plus the 3 most recent values that were obtained upon completion of the control strip. If the final moisture content lies within the allowable range of the OMC specified above, then the final dry density that was determined shall be the target density of the control strip.

501.07.04.02.05 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 subplot 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 MTO form PH-CC-009. The field dry density of each subplot 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.

MTO form PH-CC-009 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.

501.07.04.02.06 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, or small foundations (e.g., anchor blocks, sign posts, and formwork):

$$\text{For earth materials: } Q_i = \frac{\bar{x} - 95}{s}$$

$$\text{For granular materials: } Q_i = \frac{\bar{x} - 98}{s}$$

- b) For materials placed in all other situations:

$$\text{For earth materials: } Q_i = \frac{\bar{x} - 90}{s}$$

$$\text{For granular materials: } Q_i = \frac{\bar{x} - 95}{s}$$

Where:

Q_i = Quality Index, calculated to two decimal places.

$\bar{x}$ = Lot mean, the statistical value that describes the arithmetic average of subplot test results (dry density expressed as a percentage of the target density). Lot mean is the sum of individual subplot 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 subplot 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 subplot 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:

$$s = \sqrt{\frac{\sum_{i=1}^4 (x_i - \bar{x})^2}{3}}$$

501.07.04.02.07 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 recompact to meet the specified compaction requirements. Materials that cannot be successfully recompact shall be removed and replaced with new material.

501.07.04.02.07.01 Rejected Lots

If a QC lot is rejected for compaction, the lot shall be recompact with adjustment to the moisture content, as required, until satisfactory compaction is achieved. The recompact 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.

501.08.02 Compaction

501.08.02.01 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.

501.08.02.02 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/m³ for granulars and 150 kg/m³ for earth when compared with the QA average dry density, the QC test results shall be considered valid.

501.08.02.03 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.

501.08.02.04 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.

501.08.02.05 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 m³.
- 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 shall be at no additional cost to the Owner.

Replacement of unsuitable equipment to obtain an appropriate target density 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 sewer 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 sewer 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 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

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR REMOVAL

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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 provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

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 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.

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

Ontario Provincial Standard Specifications, Construction

OPSS 301	Restoring Unpaved Roadway Surfaces
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

S6-00 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.

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 MATERIAL

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 in layers not exceeding 300 mm 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 public 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 public 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 end of each completed portion and prior to opening to traffic, temporary transverse ramping shall be constructed at a slope not steeper than 120H:1V. The temporary transverse ramping shall be removed as part of continuing the removal of asphalt pavement, partial-depth operation from the ramping location or prior to placing pavement materials at the ramping location.

If, due to unforeseen circumstances, partial depth pavement removal cannot be completed to the same station for the full pavement width prior to shut down at the end of the day, then as part of the work of partial-depth pavement removal, temporary longitudinal ramping, when permitted, shall be constructed at a slope not steeper than 10H:1V prior to opening to traffic. The temporary longitudinal ramping shall be removed within 1 Day or as agreed to by the Contract Administrator in the event of weather or access restrictions.

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.

All costs associated with temporary ramping, including ramping material, shall be deemed to be included in the item price for Removal of Asphalt Pavement, Partial Depth.

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 be deemed to 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
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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
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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
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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, the contract price for the items directly associated with the removal of pipe subdrain 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.

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 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

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR INSTALLATION OF GABIONS

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512-A	Commentary

512.01 SCOPE

This specification covers the requirements for the installation of gabions and gabion structures not exceeding 2 metres in height.

512.01.01 Specification Significance and Use

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

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.

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.

512.02 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.

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 539	Temporary Protection Systems
OPSS 805	Temporary Erosion and Sediment Control Measures
OPSS 902	Excavating and Backfilling - Structures

Ontario Provincial Standard Specifications, Material

OPSS 1004	Aggregates - Miscellaneous
OPSS 1430	Gabion Baskets and Mats
OPSS 1860	Geotextiles

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.

Gabion Structure means a vertical or near vertical stacked installation of gabions.

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.

512.07.04.01 Excavation, Bedding and Backfill for Gabion Structure Not Exceeding 2.0 m Height

For gabion structures, excavation and the placing of bedding and backfill shall be according to OPSS 902.

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 according to 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 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 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 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 Protection Systems

The construction of all 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 operation, 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.

512.07.10 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.

Geotextile used with gabions shall not be measured for payment.

512.09.01.02 Gabion Structures Not Exceeding 2.0 m Height

Measurement of gabion structures not exceeding 2.0 m height shall be by volume in cubic metres based on the nominal dimensions of the gabions used. Height is measured from the base of the gabion structure and includes embedment depth, when applicable.

Geotextile used with gabion structures not exceeding 2.0 m height shall not be measured for payment.

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

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

Any costs associated with an unauthorized over-excavation shall be the Contractor's responsibility and at no extra cost to the Owner.

512.10.02 Gabion Structures Not Exceeding 2.0 m Height - 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.

Granular bedding and backfill for gabion structures shall be paid under the granular item for the material specified according to OPSS 902.

For gabion structures, excavation, bedding and backfilling shall be paid under the item Earth Excavation for Structure and Rock Excavation for Structure according to OPSS 902.

Where excavation required for gabion structure overlaps excavation required for other work, payment for excavation shall be made in accordance with the specification for the other work as though no excavation were required for the gabions and the gabion structures.

Appendix 512-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

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR TEMPORARY PROTECTION SYSTEMS

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539.10	BASIS OF PAYMENT

APPENDICES

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 provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

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 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.

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

Ontario Ministry of Transportation Publications

Structural Manual

CSA Standards

S6-06	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, 1st Edition with Interim Revisions

International Organization for Standardization/International Electrotechnical Commission (ISO/IEC)

17025 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 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.

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.

Quality Verification Engineer means an Engineer retained by the Contractor qualified to provide the services as specified in the Contract Documents.

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.

Top of Shoring Wall means the upper limit of the protection system.

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.

539.04.02.05 Milestone Inspections

539.04.02.05.01 Excavation Depths Less Than or Equal to Three Metres

The Quality Verification Engineer shall witness interim inspections of the following work:

- a) Installation of protection system, including excavation to dredge line.
- b) Removal of protection system.

A copy of the written permission to proceed shall be submitted to the Contract Administrator prior to commencement of the successive operation.

539.04.02.05.02 Excavation Depths Exceeding Three Metres

The Quality Verification Engineer shall witness interim inspections of 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.

A copy of the written permission to proceed shall be submitted to the Contract Administrator prior to commencement of the successive operation.

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 may be left in place, unless otherwise specified.

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.

Where protection systems are specified for removal or the Contractor elects to remove, the method and sequence of removal shall be so that there shall be no damage to the new work, existing work, and facility being protected.

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 during installation of the protection system 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.

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.

539.07.03.04 Certificates of Conformance

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, a completed Certificate of Conformance shall be submitted to the Contract Administrator upon completion of the operation of the protection system and removal of the protection system. The Qualification Verification Engineer's seal and signature shall be affixed on the completed Certificate of Conformance confirming that the protection system was installed, monitored, and subsequently removed in general conformance with the Working Drawings and as specified in the Contract Documents.

Should 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, a completed Certificate of Conformance shall be submitted to the Contract Administrator upon completion of the operation of the protection system and removal of the protection system. The Qualification Verification Engineer's seal and signature shall be affixed on the completed Certificate of Conformance confirming that the materials have been supplied and installed in general conformance with the Working Drawings and that the protection system was installed, monitored, and subsequently removed in general conformance with the Working Drawings and as specified in the Contract Documents.

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.

Appendix 539-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

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR STEEL BEAM GUIDE RAIL AND 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 cable guide rail systems.

721.01.01 Specification Significance and Use

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

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.

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.

721.02 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.

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-12	Carbon Structural Steel
A 780/A 780M-09	Repair of Damaged and Uncoated Areas of Hot Dip Galvanized Coatings
D 4956-11a	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 naphthenate 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

Cable guide rail shall be installed as specified in the Contract Documents.

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. The Contractor shall confirm the locations 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 guide rail end 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.

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 Cable Guide Rail

Measurement of 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 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.

721.09.01.03 Cable Guide Rail Post Replacement

For measurement purposes, a count shall be made of the number of cable guide rail post replacement installed.

721.09.01.04 Anchor Blocks

For measurement purposes, a count shall be made of the number of anchor blocks installed.

721.09.01.05 Single Rail Steel Beam Guide Rail Single Rail Steel Beam Guide Rail with Channel Double Rail Steel Beam Guide Rail

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. The length includes all treatments, transitions, and connections, but does not include terminal systems.

721.09.01.06 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. The length includes all treatments, transitions, connections, and terminal systems.

721.09.01.07 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 Cable Guide Rail - Item**
- 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**

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 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

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR ENERGY ATTENUATORS

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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 provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

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 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.

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

A 123/A 123M-13	Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
A 325-14	Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
A 780/A 780M-09	Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
D 4956-13	Retroreflective Sheeting for Traffic Control

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 3 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.

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 A 325 and shall be hot dip galvanized according to ASTM A 123.

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 A 123.

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 D 4956, 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%.

723.07.02 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 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.

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 Existing Concrete Surface

Existing 200 mm minimum thick concrete surfaces, pads, or precast pads may be used to support the energy attenuator.

723.07.03.02 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.

723.07.03.03 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.

723.07.03.04 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.

723.07.03.05 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.

723.07.03.06 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.

723.07.03.07 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

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

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

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
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
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

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 (EAP)

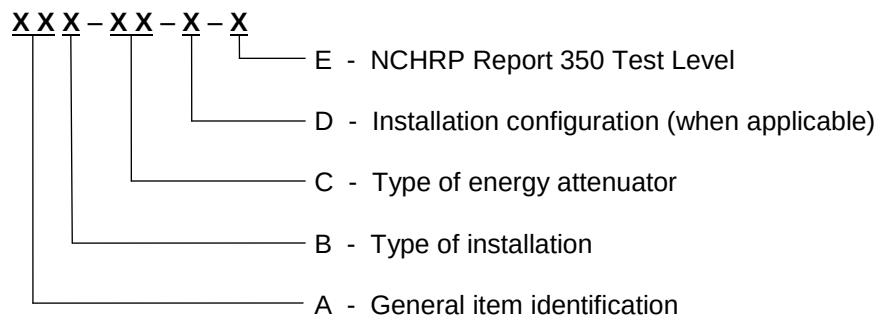
Energy Attenuator	NCHRP Report 350 Test Level		Permanent Installation					
	TL-2	TL-3	Narrow (NA)	Wide (WI)	Extra Wide (EW)	Super Wide (SW)	High Exposure (HE)	Single- Sided (SS)
TAU-II System	Yes	Yes	Yes	No	No	No	No	No
TAU-II Wide System	Yes	Yes	No	Yes	No	No	No	No
TAU-II Extra Wide System	Yes	Yes	No	No	Yes	No	No	No
Quadguard System	Yes	Yes	Yes	No	No	No	No	No
Quadguard Wide System	Yes	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
BB-BEAT	No	Yes	No	No	No	No	No	Yes
Smart System	Yes	Yes	Yes	No	No	No	Yes	No

TABLE 2
Energy Attenuator, Temporary (EAT)

Energy Attenuator	NCHRP Report 350 Test Level		Temporary Installation					
	TL-2	TL-3	Reduced Exposure (RE)	Narrow (NA)	Wide (WI)	Extra Wide (EW)	Super Wide (SW)	Dual Duty (DD)
TAU-II System	Yes	Yes	Yes	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
ABSORB 350 System	Yes	Yes	Yes	No	No	No	No	No
Quadguard System	Yes	Yes	Yes	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
ACZ 350 System	Yes	Yes	Yes	No	No	No	No	No
Smart System	Yes	Yes	Yes	Yes	No	No	No	Yes
TRACC System	Yes	Yes	Yes	Yes	No	No	No	No

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 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

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



**CONSTRUCTION SPECIFICATION FOR
GUIDE RAIL END TREATMENT - STEEL BEAM
ENERGY ATTENUATING TERMINAL SYSTEMS**

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732.05	MATERIALS
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732.08	QUALITY ASSURANCE - Not Used
732.09	MEASUREMENT FOR PAYMENT
732.10	BASIS OF PAYMENT

APPENDICES

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 provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

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.

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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.

732.02 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.

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

Ontario Provincial Standard Specifications, Material

OPSS 1601 Wood, Preservative Treatment, and Shop Fabrication

Ontario Ministry of Transportation Publications

Ontario Traffic Manual (OTM):
Book 6 - Warning Signs

ASTM International

A 123/A 123M-09 Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
A 780/A 780M-09 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/A 123M.

732.07 CONSTRUCTION

732.07.01 General

SBEAT systems shall be installed according to manufacturer's instructions at the locations specified in the Contract Documents.

When an SBEAT system is specified in the Contract Documents, the Contractor has the option of using one of the following systems:

- a) Extruder Terminal system
- b) Sequential Kinking Terminal system
- c) X-Lite Tangent Terminal system
- d) SoftStop Terminal system

When an SBEAT Type M system is specified in the Contract Documents, the Contractor has the option of using one of the following systems:

- a) MGS – ET-Plus 31 Terminal System
- b) MGS – SoftStop Terminal System
- c) MGS – Sequential Kinking Terminal System
- d) MGS – X-Lite Terminal System

SBEAT systems with steel posts shall be installed to steel beam guide rail systems with steel posts.

SBEAT systems with wooden posts shall be installed to steel beam guide rail systems with wooden or steel posts.

SBEAT systems shall be installed according to the manufacturer's instructions at locations as 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.

Wooden post tops shall be cut to the height and to the chamfer as specified in the Contract Documents.

All holes shall be drilled in the wooden posts prior to installation and in the steel posts prior to galvanizing.

The predrilled holes and the cut tops of the wooden posts shall be treated with two coats of an approved wood preservative according to OPSS 1601.

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 and SBEAT Type M 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. SBEAT Type M system mounting heights shall be within the ranges in Table 2.

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/A 780M. 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 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
Extruder Terminal	685 to 760	685 to 735
Sequential Kinking Terminal	685 to 760	685 to 735
X-Lite Tangent Terminal	685 to 760	685 to 735
SoftStop Terminal	760 to 810	760 to 810

TABLE 2
SBEAT Type M System Mounting Heights

System	Height During Construction and Seasonal Shutdown mm	Height for Completion of the Work mm
MGS ET-Plus 31 Terminal	760 to 810	760 to 810
MGS SoftStop Terminal	760 to 810	760 to 810
MGS Sequential Kinking Terminal	760 to 810	760 to 810
MGS X-Lite Tangent Terminal	760 to 810	760 to 810

Appendix 732-A, April 2016
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

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Designer Action/Considerations

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR STANDARD HIGHWAY FENCE

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771.10	BASIS OF PAYMENT

APPENDICES

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 provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

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.

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771.02 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.

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

A 780 / A 780M-09 Standard Practice for Repair of Damaged and Uncoated Areas of Hot Dip Galvanized Coatings

B 209-10 Aluminum Alloy Sheet and Plate

771.03 DEFINITIONS

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

Brace Post means the wooden post installed to anchor the diagonal wooden brace within the brace panel.

Corner Post means the terminal post installed at horizontal deflections in the fenceline 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.

Steel Brace Panel means the steel brace, steel line post, angle iron, and grout.

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.

Wooden Brace Panel means the diagonal wooden brace, wooden brace post, brace wire, fasteners, and when installed in rock, steel T-rail posts with 3.5 mm wire and grout.

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 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.

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 fenceline 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. The Contractor 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 fenceline, 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 than 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 949-12-9.75 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 949-12-9.75 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 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., 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 A 780.

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 according to 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 Owner 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.

771.10.02 Removals and Replacements

Costs associated with any required removals and replacements of defective workmanship or materials shall be the Contractor's responsibility at no additional cost to the Owner.

Appendix 771-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

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR SEED AND COVER

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804-A	Commentary

804.01	SCOPE

This specification covers the requirements for seeding alone or seeding with either rolled or hydraulically applied erosion control products.

804.01.01 Specification Significance and Use

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

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.

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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804.02 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.

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 Seeds Act (R.S., 1985, c. S-8)
Ontario Water Resources Act

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).

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 submitted to the Contract Administrator for review a minimum of 24 hours prior to any seeding operations.

804.05 MATERIALS

804.05.01 Seed

804.05.01.01 Certificate of Seed Analysis

The Certificate of Seed Analysis shall identify the seed supplier's lot designation numbers.

Test results from the Certificate of Seed Analysis shall show the 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.

804.05.01.02 Seed Packaging, Labeling, and Storage

All seed and seed mixes shall be in the original factory sealed package with the original legible label securely attached.

Labeling shall be in accordance with the requirements of the Canada Seeds Act and Regulations. Each package shall be labeled 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.

804.05.01.03 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 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 Mulch

Mulch shall be either a mixture of straw mulch and straw mulch tackifier or hydraulic mulch.

804.05.04.02 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.

804.05.04.03 Straw Mulch Tackifiers

Organic straw mulch tackifiers may include wood and fibre paper mulch or guar and starch based tackifiers. Asphalt based tackifiers shall not be used.

804.05.04.04 Hydraulic Mulch

Hydraulic mulch shall consist of shredded wood or paper fibres or both, water or a stabilizing emulsion or both.

Stabilizing emulsions shall consist of an organic tackifier or an inorganic polymer. Common stabilizing emulsions include guar gum, psyllium, or polyacrylamide or all three.

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 form 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.

804.05.04.05 Matrix

Matrix shall be Bonded Fibre Matrix (BFM) or Fibre Reinforced Matrix (FRM).

804.05.04.06 Bonded Fibre Matrix (BFM) and Fibre Reinforced Matrix (FRM)

BFM shall consist of thermally refined wood fibers and 10% by weight cross-linked hydro-colloidal tackifiers. BFM shall be 100% biodegradable. The curing period for BFM shall be not more than 48 hours.

FRM shall consist of thermally refined wood fibers, 10% by weight cross-linked hydro-colloidal tackifiers, and 5% by weight crimped man-made fibers. FRM shall be 100% biodegradable. FRM shall not have a curing period.

BFM and FRM shall be hydraulically applied and after application be capable of adhering to the soil. In a dry state, BFM and FRM 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 or FRM shall form a viscous material that when applied and dried creates a high strength, porous, and erosion-resistant uniform, cohesive mat. The bonding agent shall not dissolve or disperse upon re-wetting. BFM and FRM shall not inhibit the germination or growth of plant material.

804.05.04.07 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 or may 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.

804.07 CONSTRUCTION

804.07.01 Operational Constraints

The seeding operation shall not commence until the Contract Administrator has approved the surface preparation and the layout of seed mix locations and cover types.

Seed only and seed and cover applications or re-applications 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.

Seeded earth areas shall be maintained and erosion controlled 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 personnel certified and trained by the manufacturer in the proper mixing and installation of the product. BFM shall not be applied when rainfall is expected within 48 hours, during rainfall, or within 12 hours after rainfall.

804.07.02 Surface Preparation for Seeding

The surface to be seeded shall be prepared not more than 5 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.

804.07.03 Layout

The locations and limits of the seed mixes and cover types 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. The water slurry shall be applied to the prepared earth areas by the nozzle sprayer or extension hose.

The seeding equipment shall be calibrated to provide the coverage shown in Table 2. There shall be a uniform dispersal of the mixed material over the entire area designated for seeding. The spray shall not dislodge soil or cause erosion.

Seed and fertilizer may be applied separately by a cyclone spreader.

Seeding shall overlap the adjoining ground cover by 300 mm.

804.07.05 Cover Application

Mulch, ECB, and matrix cover materials shall be applied at the locations specified in the Contract Documents as a separate operation immediately following the application of seed and fertilizer.

The hydraulic seeder and mulcher shall be properly calibrated to provide the coverage as specified for each of the hydraulically applied cover materials.

804.07.05 Cover 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 m². Hydraulic mulch shall be thoroughly mixed with water into a homogeneous slurry.

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) or Fibre Reinforced Matrix (FRM) Application

BFM or FRM shall be applied at a minimum rate of 3,700 kg of dry product per 10,000 m². BFM and FRM shall be thoroughly 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.

The BFM and FRM slurry shall be applied to the seeded earth areas by nozzle sprayer or extension hose. The BFM and 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 ECB shall be anchored to the soil and tenting of the ECB shall not occur.

On slopes, the uppermost edge of the ECB shall be extended 1 metre beyond the crest of the slope and anchored. When extension beyond the crest of the slope is not possible, the ECB shall be anchored in a 150 mm wide by 150 mm deep trench excavation at the top of the slope. The trench shall be backfilled with the excavated native material 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 seed and cover materials shall be immediately removed from the trees, shrubs, plant material, and waterbodies and the trees, shrubs, and plant material washed with clean water.

When seed and cover materials are applied to areas or objects other than those designated, the seed and cover materials shall be removed from the areas and objects.

804.07.07 Protection of Waterbodies and Waterbody Banks

Protection of waterbodies and waterbody banks shall be as specified in the Contract Documents.

804.07.08 Management of Excess Material

Management of excess material shall be as specified in the Contract Documents.

804.08**QUALITY ASSURANCE****804.08.01****Performance Measure**

All seeded areas shall be inspected by the Contract Administrator using the Seeding and Cover Quality Assurance Visual Inspection Field Guide (SCQAVIFG) to ensure compliance with this specification at 30, 60, and 90-Day periods following the seed 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 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 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 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 Referee Evaluation

Referee evaluation shall only apply 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 evaluation. 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 quadrant 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 evaluation 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 referee evaluation process.

If the results of the referee evaluation 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 referee evaluation process.

804.09 MEASUREMENT FOR PAYMENT

804.09.01 Actual Measurement

804.09.01.01 Seed

Seed measurement shall be in square metres following the contours of the ground without any allowance for overlap.

804.09.01.02 Seed and Mulch

Seed and mulch measurement shall be in square metres following the contours of the ground without any allowance for overlap.

804.09.01.03 Seed and Erosion Control Blanket

Seed and erosion control blanket measurement shall be in square metres following the contours of the ground without any allowance for overlap.

804.09.01.04 Seed and Matrix

Seed and matrix 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 - Item

Seed and Mulch - Item

Seed and Erosion Control Blanket - Item

Seed and 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: <i>Festuca rubra</i>					52	45 to 60
Kentucky Bluegrass: <i>Poa pratensis</i>					10	5 to 15
Perennial Ryegrass: <i>Lolium perenne</i>					35	30 to 40
White Clover: <i>Trifolium repens</i>					3	2 to 7
Crown Vetch Mix	Common #1 Ground Cover	70	N/A	0.5		
Creeping Red Fescue: <i>Festuca rubra</i>					66	62 to 70
Crown Vetch: <i>Coronilla varia</i> inoculated seed					34	30 to 38
Birdsfoot Trefoil Mix	Common #1 Forage Mixture	75	N/A	0.5		
Creeping Red Fescue: <i>Festuca rubra</i>					66	62 to 70
Birdsfoot Trefoil: <i>Lotus corniculatus</i> inoculated seed					34	30 to 38
Salt Tolerant Mix	Canada #1 Ground Cover	70	85	0.5		
Tall Fescue: <i>Festuca arundinacea</i>					25	20 to 30
Fults Alkali Grass: <i>Puccinellia distans</i>					20	15 to 25
Creeping Red Fescue: <i>Festuca rubra</i>					25	15 to 30
Perennial Ryegrass: <i>Lolium perenne</i>					20	15 to 25
Hard Fescue: <i>Festuca trachyphylla</i>					10	5 to 15

Continues on Next Page

Permanent Seed Mix	Grade Name	Minimum Seed Germination %	Minimum Seed Purity %	Maximum Weed Seed %	Seed Mix %	Seed Species Composition %
Lowland Mix	Canada #1 Ground Cover	70	N/A	0.5		
Creeping Red Fescue: <i>Festuca rubra</i>					35	30 to 40
Brome Grass: <i>Bromus nerrres</i>					25	20 to 30
Kentucky Bluegrass: <i>Poa pratensis</i>					10	5 to 15
Birdsfoot Trefoil: <i>Lotus corniculatus</i> inoculated seed					5	3 to 7
White Clover: <i>Trifolium repens</i>					5	3 to 7
Perennial Ryegrass: <i>Lolium perenne</i>					20	15 to 25
Acidic Soil Mix	Canada #1 Ground Cover	70	N/A	0.5		
Birdsfoot Trefoil: <i>Lotus corniculatus</i> inoculated seed					30	25 to 40
Red Top: <i>Agrostis gigantea</i>					10	5 to 15
Tall Fescue: <i>Festuca arundinacea</i>					15	10 to 20
Creeping Red Fescue: <i>Festuca rubra</i>					30	25 to 35
Hard Fescue: <i>Festuca trachyphylla</i>					5	3 to 7
Alsike Clover: <i>Trifolium hybridum</i>					5	3 to 7
Red Clover: <i>Trifolium pratense</i>					5	3 to 7

Continues on Next Page

Permanent Seed Mix	Grade Name	Minimum Seed Germination %	Minimum Seed Purity %	Maximum Weed Seed %	Seed Mix %	Seed Species Composition %
Old Field Mix	Canada #1 Ground Cover	70	N/A	0.5		
Flat-topped Aster: <i>Aster umbellatus</i>					37	35 to 40
New England Aster: <i>Aster novaeangliae</i>					17	10 to 20
Purple-stemmed Aster: <i>Aster punicens</i>					16	10 to 20
Canada Goldenrod: <i>Solidago Canadensis</i>					12	10 to 15
Panicled Aster: <i>Aster simplex/lanceolatus</i>					8	6 to 10
Heath Aster : <i>Aster ericoides</i> or Frost Aster: <i>Aster pilosus</i>					5	3 to 7
Grass-leaved Goldenrod: <i>Solidago memorialis</i>					5	3 to 7
Northern Ontario Mix	Canada #1 Ground Cover	70	N/A	0.5		
Red Top: <i>Agrostis gigantean</i>					3	1 to 5
Canada Bluegrass: <i>Poa compressa</i>					7	5 to 15
Creeping Red Fescue: <i>Festuca rubra</i>					40	35 to 45
Birdsfoot Trefoil: <i>Lotus corniculatus</i> inoculated seed					5	2 to 8
Alsike Clover: <i>Trifolium hybridum</i>					3	1 to 5
White Clover: <i>Trifolium repens</i>					2	1 to 5
Perennial Rye Grass: <i>Lolium perenne</i>					30	25 to 35
Meadow Fescue: <i>Festuca pratensis</i>					10	5 to 15

TABLE 2
Application Rates for Seed and Fertilizer

Permanent Seed Mixes	Permanent Seed Mix Rate kg/10,000 m ²	Fertilizer Rate minimum 200 kg/ha			Nurse Crop Rate kg/10,000 m ²
		8-32-16	0-46-0	0-0-60	
Standard Roadside Mix	170	365			60
Crown Vetch Mix	140	365	260		60
Birdsfoot Trefoil Mix	140	365	260		60
Salt Tolerant Mix	170	350			60
Lowland Mix	170	350			60
Acidic Soil Mix	170	350	220	220	60
Old Field Mix	140	350			60
Northern Ontario Mix	170	365			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 Waubesa, Severn Bridge, Bancroft, and Ottawa.
November 15 to April 15 inclusive	November 1 to April 30 inclusive	October 1 to June 1 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

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR DEEP FOUNDATIONS

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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 provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

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 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.

This specification refers to the following specifications, standards, 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

G40.20-04/G40.21-04 (R2009)	General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel
CAN3-056-1962(R2006)	Round Timber Piles
O80 Series-08	Wood Preservation
W47.1-03 (R2008)	Certification of Companies for Fusion Welding of Steel
W48-06	Filler Materials and Allied Materials for Shielded Metal Arc Welding
W59-03(R2008)	Welded Steel Construction (Metal Arc Welding)
W178.1-08	Certification of Welding Inspection Organizations
W178.2-08	Certification of Welding Inspectors

Canadian General Standards Board (CGSB)

48.9712-2006 Non-destructive Testing, Qualification and Certification of Personnel

ASTM International

A 252-98(2007) Welded and Seamless Steel Pipe Piles
A 328/A 328M-07 Steel Sheet Piling
D 1143/ D 1143M-07 Standard Test Methods for Deep Foundations Under Static Axial Compressive Load
D 3689-07 Standard Test Methods for Deep Foundations Under Static Axial Tensile Load
D 3966-07 Standard Test Method for Deep Foundations Under Lateral Loads

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, 4th Edition,

Steel Structures Painting Council (SSPC)

SP10/NACE No.2-Jan. 1, 2001 Near-White Blast Cleaning

International Organization for Standardization/International Electrotechnical Commission (ISO/IEC)

17025 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.

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.

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.

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

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.

Quality Verification Engineer (QVE) means an Engineer retained by the Contractor qualified to provide the services specified in the Contract Documents.

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 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

The Quality Verification Engineer shall witness the following interim inspections of the work for caisson piles:

- a) Excavation
- b) Steel reinforcement installation
- c) Placing of concrete

A copy of the written permission to proceed shall be submitted to 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 Qualifications

Copies of the Canadian Welding Bureau's certification of the Independent Testing Company, the Non-destructive Testing Technician, and the Welding Inspector shall be submitted to the Contract Administrator at least 5 Days prior to the commencement of any non-destructive testing, for information purposes only.

903.04.02.06 Review of Splice Test Results and Permission to Proceed

Upon completion of the testing of the splices, the Quality Verification Engineer shall review all test results to verify that all the 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 CAN3-056 and shall be clean and peeled. Treated piles shall be pressure treated with creosote according to CAN/CSA-080.

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 CAN/CSA G40.20/G40.21, Grade 350 W.

903.05.02.02 Tube Piles

Steel tube piles shall be according to ASTM A 252, minimum Grade 2.

903.05.02.03 Sheet Piles

Steel sheet piles shall be according to ASTM A 328M.

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 A 252, 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. When approved by the Contract Administrator in writing, admixtures may be used. Where the liner is to be withdrawn, sufficient retarder shall be added 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 or APF Hard Bite, standard model, may be substituted for the driving shoes.

When Oslo points are specified in the Contract Documents, the Titus H bearing pile point or APF, 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 the pieces being spliced are not less than 3 m long. Splices in marine structures shall be located below the low water level, unless otherwise 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. The QVE or an individual under the direct supervision of the QVE shall verify the work.

Piles shall not be overdriven. When driving to a specified ultimate resistance, driving to a set or driving to bedrock, the piles shall be driven to the anticipated tip elevation. The Contract Administrator shall be notified if

the piles do not reach set at the anticipated tip elevation, .

In soils where there is a possibility of piles moving upward due to ground heave, elevations of completed pile tops shall be measured at intervals while nearby piles are being installed. The readings shall be recorded and submitted to the Contract Administrator as the work proceeds.

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 Quality Verification Engineer 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 Quality Verification Engineer. The Quality Verification Engineer 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 Quality Verification Engineer 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 Quality Verification Engineer 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 $\frac{1}{4}$ 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-1. All 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 Quality Verification Engineer.

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 Quality Verification Engineer 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.

The QVE or an individual under the direct supervision of the QVE shall verify the installation of displacement caisson piles.

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 D 1143M for piles under vertical static load, ASTM D 3689 for piles under tensile load, and ASTM D 3966 for piles under lateral loads. The Quality Verification Engineer shall witness the pile load test. All records and results of the

pile load test attached with the Certificate of Conformance 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.

903.07.08 Quality Control

903.07.08.01 Inspection and Testing of Welds

903.07.08.01.01 Qualifications of Companies and Individuals

An independent testing company with no corporate affiliation with the Contractor shall be employed to 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 an 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 CAN/CGSB-48.9712 and the Canadian Welding Bureau for the non-destructive testing specified.

Visual inspections shall be performed by a welding inspector employed by an independent testing company. The welding inspector shall have documented evidence of training, professional knowledge, skill and experience in the visual inspection of structural steel welds and material, and have a valid certificate showing qualification to Level II or III according to CSA W178.2.

903.07.08.01.02 Visual Inspection of Welds

A representative sample of not less than 30% of the welds, as determined by the Quality Verification Engineer, shall be visually inspected for conformance to the requirements of CSA W59, the Contract Documents, and the Working Drawings.

903.07.08.01.03 Non-Destructive Testing of Welds

Radiographic or ultrasonic testing shall be carried out 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 Quality Verification Engineer 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.

903.07.08.01.04 Repaired Welds

All welds that have been repaired shall be visually inspected and shall undergo non-destructive testing.

903.07.08.02 Non-Destructive Test Reports and Visual Inspection Reports

Within 7 Days from completion of the inspection and testing, two copies of all inspection and testing reports shall be submitted to the Contract Administrator, for information purposes only.

903.07.08.03 Certificate of Conformance

A completed Certificate of Conformance shall be submitted to the Contract Administrator upon completion of the deep foundation work. The Certificate of Conformance shall be sealed and signed by the Quality Verification Engineer and shall state that the deep foundation work has been carried out in general conformance with the Contract Documents and Working Drawings. The Certificate of Conformance shall also certify that the interim milestone inspections have been completed as specified.

When the specified horizontal tolerances are not achieved, the process for "Non-Conforming Work by the Contractor" as specified elsewhere in the Contract Documents shall be followed unless the pile discrepancies are minor and do not require a detailed design evaluation.

For these minor cases, a proposal for an amendment to the Contract Documents stating that the pile discrepancies are minor and do not require detailed design evaluation shall be submitted to the Contract Administrator for acceptance.

The proposal shall be signed by an Engineer and shall be accompanied by a drawing containing the following information:

- a) Specified pile locations;
- b) Actual pile locations; and
- c) Proposed adjustments to the footing and reinforcement.

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 administered as a Change in the 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, April 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

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR CONCRETE STRUCTURES

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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 provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

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 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.

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

MTO Forms:

PH-CC-736 Notification of Placement of Structural Concrete

CSA Standards

G30.18.09 Carbon Steel Bars for Concrete Reinforcement

ASTM International

- A 955M/A 955M-12e1 Deformed and Plain Stainless Steel Bars for Concrete Reinforcement
- 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.

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 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.

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.

High Performance Concrete (HPC) means concrete with a minimum specified 28-Day compressive strength of at least 50 MPa that includes silica fume and may include other supplementary cementing materials and having a specified rapid chloride permeability at 28 to 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.

Reinforcing Steel Bars means deformed steel bars made of carbon steel as defined in CAN/CSA G30.18, 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 Bars means deformed stainless steel bars as defined in ASTM A955 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.

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. For the purposes of this specification, a working slab is not considered a structural component.

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

Prior to each placing operation, the Contractor shall complete and submit MTO form PH-CC-736, accompanied by all supporting documentation as indicated on the form, to the Contract Administrator.

904.04.01.02 Bridge Deck Placement Plan

A work plan shall be submitted to the Contract Administrator a minimum of 7 Days 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 7 Days prior to commencement of placing any concrete that requires temperature control for review of compliance with the requirements as specified in the Contract Documents.

The plan shall include methods for monitoring and controlling concrete temperature and the temperature difference prior to, 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 Curing Compound

A minimum of 7 Days prior to the application of the curing compound, the following shall be submitted to the Contract Administrator, for information purposes:

- a) Literature stating the manufacturers 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.

904.04.01.05 Approach Slab Seat Elastomers and Ballast Wall Elastomers

A copy of the manufacturer's certificate verifying compliance with OPSS 1202 shall be submitted to the Contract Administrator prior to installation of the approach slab seat elastomer or ballast wall elastomer or both.

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 sufficient water to produce a consistency so 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 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.

904.05.07 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.

904.05.08 Moisture Vapour Barrier

The material shall be a white opaque polyethylene film according to ASTM C 171, at least 100 µm thick.

904.05.09 Curing Compound

Curing compound shall be according to OPSS 1315.

904.05.10 Approach Slab Seat Elastomers and Ballast Wall Elastomers

Elastomers delivered to the site shall exceed the required length to allow for a 600 mm test sample to be taken from the approach slab seat or ballast wall elastomers on each structure.

The elastomer shall be according to the plain bearing requirements of OPSS 1202.

904.05.11 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 m² 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.

904.06 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.

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 Bridge Deck Finishing Machine

The bridge deck 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 screw power 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 a mechanical agitator.

904.06.12 Compressor - Air Blasting

The compressor for air blasting shall have a minimum capacity of 3.5 m³/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 prior to any concrete is placed. This requirement does not apply to the bottom slab of post-tensioned decks with trapezoidal voids.

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 ± 2 mm by means of methods such as scabbling, chipping, or bush hammering 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 Cleaning

All concrete and structural steel surfaces against which new concrete is to be placed shall be cleaned by power washing no more than 24 hours prior to placing concrete.

904.07.04.04 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.

904.07.04.05 Bonding Agent

A bonding agent shall be used for:

- a) Exposed vertical surfaces of concrete, less than 300 mm in height, 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 prior to 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.

904.07.04.06**Element-Specific Preparation**

For concrete in footings, when specified in the Contract Documents 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 prior to 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 grade thoroughly wetted down prior to placing the concrete in the approach slab.

For concrete in slope paving, the slope face shall be shaped; excavation completed; granular A placed and compacted according to OPSS 501; 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.

904.07.05**Placing of Concrete****904.07.05.01****General**

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. 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.

904.07.05.02**Concrete Placing Restrictions**

No concrete shall be placed until the Contract Administrator has signed the submitted MTO form, PH-CC-736, verifying receipt of all the required information.

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 is 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 any other 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.

904.07.05.03 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 prior to any concrete is placed.

A dry run shall be carried out in the presence of the Contract Administrator 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.

904.07.05.04 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 m³/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 of 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 concreting operation restarted. 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 prior to 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.

904.07.06 Consolidation

Internal or external vibrators or both shall be used to thoroughly consolidate concrete at the point of deposit within 15 minutes of placement.

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.

904.07.07 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.

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.

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. After a tight, uniform surface has been achieved, texturing shall be done 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 150 to 300 mm of the curb.

Bearing seats and expansion joint dams shall receive a wooden float finish. The top surface of sidewalks and curbs shall be given a broomed finish.

Concrete surfaces against which new concrete is to be placed shall be left with a rough surface finish.

904.07.08 Curing

904.07.08.01 General

Curing shall be applied immediately after finishing the concrete surface. For continuing operations, such as barrier wall or sidewalk, the curing 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.

Any concrete containing silica fume shall be cured according to the HPC curing requirements.

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 and shall not be used when cold weather concreting is in effect.

Where waterproofing is to be applied to a structure deck following curing with burlap and water or moisture vapour barrier, the deck shall be air cured for at least 72 hours prior to the application of waterproofing.

904.07.08.02 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 a 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.

904.07.08.03 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 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 prior to the concrete has achieved final set.

904.07.08.04 Curing with Moisture Vapour Barrier

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.

904.07.08.05 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 to completely cover 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.

904.07.08.05.01 Curing Compound Sampling

The Contractor shall be responsible for sampling of curing compounds and handling, identification, and delivery of curing compound samples to Regional Quality Assurance Laboratory for Quality Assurance testing. Curing compounds shall be sampled at the site from the spray nozzle during application. 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.

904.07.08.06 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.

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.

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 prior to 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.

904.07.09 Control of Temperature and Temperature Difference

904.07.09.01 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) All bridge decks.
- b) HPC.
- c) Large concrete components where the smallest dimension is 1.5 m.
- d) Any concrete subject to cold weather.

904.07.09.02**Monitoring**

The Contractor shall monitor, record, and submit records for the concrete and ambient air temperature for:

- a) All bridge decks.
- b) HPC.
- c) Large concrete components where the smallest dimension is 1.5 m.
- d) Any concrete subject to cold weather.

The Contractor shall supply and install thermocouple wires and associated instrumentation with a combined accuracy of ± 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 as shown in Table 1 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 minimum 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 digital temperature indicators shall be left in place until the end of the monitoring period.

The Contractor shall also physically monitor and verify concrete and ambient air temperature readings 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. 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.

The Contractor shall prepare a record of temperatures for each Day during the temperature monitoring period and at the end of the temperature monitoring period shall prepare complete temperature records, including graphical plot of temperature versus time.

904.07.09.02.01**Submission of 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 Business 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.

904.07.09.03**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 as shown in Table 2 and shall be maintained for the duration of the curing period. This period may need to be extended in order to meet the requirement of the Withdrawal of Protection clause.

904.07.09.03.01 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.

904.07.09.04 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 shown in Table 3, 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.

904.07.10 Removal of Formwork and Falsework

The removal of formwork and falsework shall be according to OPSS 919 and as specified in the Contract Documents.

904.07.11 Construction Joints

The Contractor shall form construction joints at the locations specified in 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.

904.07.12 Surface Finish

904.07.12.01 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 any 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 the manufacturer's instructions.

Surfaces with cavities with any dimension 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.

904.07.12.02 Exposed Surfaces

The appearance of the concrete shall be uniform in colour, pattern, and texture when viewed from a distance of 15 m. Care shall be taken to select material, including proprietary patching materials, to achieve uniformity of colour and appearance.

The Contractor shall remove all projections, such as fins and bulges, and all blemishes, such as stains and rust marks.

904.07.12.03 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.

904.07.12.04 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.

904.07.13 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 as 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 ± 25 mm.

904.07.14 Testing for Early Strength

The Contractor may elect to 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 Documents.

Early strength determination of concrete in post-tensioned structures shall be carried out on a minimum of 4 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 shall reach the minimum stressing strength as specified in the Contract Documents prior to stressing can commence.

904.07.15 Early Loading of Structural Concrete

Full design loads shall not be applied to the structure until the specified 28-Day compressive strength has been attained. Early loading of a structural component is permitted, unless expressly stated otherwise in the Contract Documents, subject to the following conditions:

- a) Prior to any early loading, the Contractor shall demonstrate that the concrete has reached a compressive strength of 20 MPa by preparing, curing, and transporting early strength cylinders according to the Testing for Early Strength subsection.
- b) Subsequent placement of reinforcement, formwork and falsework on a footing, culvert base slab, or caisson shall not begin until at least 24 hours after concrete placement, provided that concrete in the footing, culvert base slab, and caisson can withstand the forces exerted. Placement of concrete on the footing, culvert base slab, or caisson shall not be carried out until the concrete has reached a compressive strength of 20 MPa.
- c) Subsequent placement of reinforcement, formwork, falsework, and concrete on all other structural components shall not be carried out until the concrete has reached a compressive strength of 20 MPa.
- d) Early loading of concrete is not permitted where cold weather protection is required.
- e) Construction vehicles shall not be permitted on bridge decks until the concrete has reached a compressive strength of 20 MPa and construction vehicles shall not be permitted on the cantilever portion of the bridge deck until the specified 28-Day compressive strength has been achieved. Gross vehicle weight of the construction vehicles shall not exceed 20,000 kg.
- f) Full curing is to be maintained at all times as specified in the Contract Documents.

904.07.16 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 as shown in Table 4, 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 prior to 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.

904.07.17 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 requirements as specified in the Contract Documents, 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, not more than one month after removal of curing.

904.07.18 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 any other deficiencies.

904.08.02 Concrete Cover

The concrete cover shall meet the requirements as specified in the Contract Documents. 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 and Ballast Wall Elastomers

The Contract Administrator shall select a random sample of the approach slab seat and ballast wall elastomers, 600 mm in length each, from each structure for testing.

The elastomer samples shall be delivered by the Contractor to:

Head, Concrete Section
Ontario Ministry of Transportation
Room 15, Building C
1201 Wilson Avenue
Downsview, ON M3M 1J8

Elastomers that do not meet the requirements as specified in the Contract Documents shall be considered unacceptable and a financial penalty shall be applied.

904.08.04 Curing Compounds

Curing compounds shall be tested for relative density, non-volatile content, and settlement according to LS-413, LS-414, and LS-416. The individual test results shall be forwarded to the Contractor as they become available.

Curing compound that fails to fall within the specified tolerances for relative density, non-volatile content, or settlement shall be deemed unacceptable and curing compound represented by samples that do not comply with the requirements of this specification shall not be used for curing of concrete.

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 m².
- 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.

904.09.03 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 as specified in the Contract Documents.

Surface cavities greater than 50 mm and honeycombing shall be repaired at no additional cost to the Owner.

904.10.02 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.

904.10.03 Working Slabs

When a concrete working slab is required by the Contract Administrator, payment shall be made as a Change in the Work at the unit price of the concrete in the footing to be placed on it.

904.10.04 Deck Joint Assemblies, Bearings, and Deck Drains

When the Contract does not contain a separate tender item 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 to place the deck joint assemblies, bearings, and deck drains.

904.10.05 Reinforcing Steel Bars, or Stainless Steel Reinforcing Bars

When the Contract does not contain a separate tender item for 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 to place the reinforcing steel bars or stainless steel reinforcing bars.

TABLE 1
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	At locations where the concrete is expected to reach the highest temperature and at the surface of concrete.
Bridge Decks	All.	a) Minimum of 3 per stage, or per deck if deck is not placed in stages. b) 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. At 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	At 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 m	Elements with smallest dimension of 1.5 m or more.	Minimum of 3 per element or stages thereof.	2	At 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 3 consisting of 1 mid-depth thermocouple and 2 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 2
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 3
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 4
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	Repair cracks in the areas where total linear measurement of crack per m^2 is < 5 m. 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	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. 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	Repair cracks in the areas where the total linear measurement of crack per linear meter of the curb is < 1.5 m. 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 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

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR STEEL REINFORCEMENT FOR CONCRETE

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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 provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

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 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.

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

Ontario Provincial Standard Specifications, Construction

OPSS 616	Footings and Pads for Electrical Equipment
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
S6-06	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 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:

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.

Splice-Reinforcing Steel means a connection of one steel reinforcement to another by lapping, welding, mechanical couplings, or other means or the lap between sheets or rolls of welded wire fabric.

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

Three sets 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, and spacing for all steel reinforcement.

When a metric to imperial bar size substitution is made, the placing drawings shall include the quantity, bar size, grade, location, and spacing 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

Three sets 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

Three sets 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

Three sets 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 Connections 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 Tests 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. All supports or support systems shall be capable of withstanding the loads to be placed on them. Except for tie wire, all embedded hardware within 50 mm of exposed faces shall be coated with an acceptable material or be of an acceptable non-metallic material.

Tie wire shall be annealed ferrous wire 2.6 mm in diameter.

Tie wire used to tie stainless steel reinforcing bars to stainless steel reinforcing bars, reinforcing steel bars, and shear studs, shall be Type 316 LN or Type 316L, stainless steel wire, 1.2 or 1.6 mm in diameter.

Bar chairs for supporting stainless steel reinforcing bars shall be non-metallic. Concrete chairs shall not be used to support stainless steel reinforcing bars.

905.07 CONSTRUCTION

905.07.01 General

All steel reinforcement and accessories shall be kept clean of all 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

905.07.02.01 Storage and Protection of Stainless Steel Reinforcing Bars

Stainless steel reinforcing bars shall be stored separately from reinforcing steel bars with the bar tags maintained and clearly visible until ready for placement.

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 the correct location 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 equally spaced around the spiral and shall be so that the specified pitch of the spiral is maintained.

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 Standard 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 effected by 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 Tests 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 Tests

When mechanical connectors are used, sample connections shall be assembled at the work site in the presence of the Contract Administrator to be used for testing by the Owner. Frequency of sampling and method of sample assembly shall be according to the Quality Assurance section.

905.07.02.08.02 Interim Inspection After Installation of Mechanical Connectors

Upon completion of job control testing and installation of connectors, and prior to placing of concrete, the Quality Verification Engineer shall conduct an interim inspection of the work to verify that the mechanical connectors meet the requirements of and are installed in general conformance with the Contract Documents.

905.07.03 Prestressing Steel for Prestressed Concrete

905.07.03.01 Surface Condition

All prestressing steel shall be clean and free of all rust, oil, dirt, scale, and pitting. Prestressing steel may have a light oxide coating.

905.07.03.02 Placing

Prestressing steel shall be accurately placed in the positions as specified in the Contract Documents and held in the correct location during the operations of placing and compacting concrete.

Prestressing steel shall be placed according to the tolerances shown in Table 1.

Mechanical connections in strand or high strength bars shall not be permitted in the work, unless specified in the Contract Documents.

Mechanical connections shall be installed according to the recommendations of the manufacturer of the prestressing system used.

905.07.03.03 Welding

Welding of prestressing strand shall not be permitted.

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 Certificate of Conformance for Placing Reinforcement

Upon completion of placing reinforcement for each component and prior to placing of concrete, a certificate of conformance sealed, signed, and dated by the Quality Verification Engineer shall be submitted to the Contract Administrator. The certificate shall state that the Work has been carried out in general conformance with the sealed and signed Working Drawings and Contract Documents.

The certificate of conformance requirements of this specification do not apply to footings and pads for electrical equipment that are constructed according to OPSS 616.

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

The Contractor shall notify the Contract Administrator when prestressing steel is available for sampling.

Samples selected by the Contract Administrator shall be properly labeled by the Contractor for submission at least 3 weeks in advance of anticipated use to the Owner's laboratory or as directed by the Contract Administrator.

Samples of the prestressing steel shall be provided as follows:

- a) For strand, 1 sample 1.0 m long from each reel.
- b) For anchorages and connectors, samples shall be selected by the Contract Administrator on a random basis.

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.

Three 1.5 m long randomly selected samples of each bar size supplied in a lot of stainless steel reinforcing bars 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:

Head, Concrete Section
Ontario Ministry of Transportation
Room 15, Building C
1201 Wilson Avenue
Downsview, Ontario, M3M 1J8

905.08.01.03 Mechanical Connectors - Sampling for Job Control Test

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 three sample connections per subplot or three 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.

Each assembled test sample shall be tagged with a weatherproof marking, which clearly identifies the Contract number, subplot number, connector bar size, number of connectors within the subplot, date of supply to the Contract site, and name of manufacturer. The Contractor shall deliver the samples to the Regional Quality Assurance laboratory with mill test certificates representative of the steel reinforcement used.

905.08.02 Testing

905.08.02.01 Prestressing Steel

The testing of prestressing steel shall be according to ASTM A 421M.

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

Mechanical connectors shall be tested for slip and tensile strength according to the ministry's laboratory test method LS-434.

If any one of the three test samples for a subplot fails either the slip test or the strength test, then two new referee sample connections shall be prepared by the Contractor from the same subplot and tested along with the remaining connectors.

In this case a total of four samples are required to meet requirements for slip and tensile strength for the subplot to be considered acceptable. If any of the new samples do not meet the requirement of the slip test or the tensile strength test, the subplot shall be rejected.

The above procedure shall be repeated for the next subplot. If an additional subplot fails, then the remainder of the lot shall be rejected and the Contractor shall submit to the Contract Administrator a proposal for replacing this lot for his approval.

Only qualifying sublots shall be used in the work.

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	± 20	± 15
ii) Bottom	± 10	± 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 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

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR METAL TRAFFIC BARRIERS AND METAL RAILINGS FOR STRUCTURES

TABLE OF CONTENTS

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908-A	Commentary

908.01 SCOPE

This specification covers the requirements for metal traffic barriers and metal railings for structures including posts and anchors.

908.01.01 Specification Significance and Use

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

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 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.

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

Ontario Provincial Standard Specifications, Construction

OPSS 906	Structural Steel
OPSS 911	Coating for Structural Steel Systems

Ontario Ministry of Transportation Publications

Designated Source for Materials (DSM)

CSA Standards

G40.20/G40.21-04 (R2009)	General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steels
O80-Series 08	Wood Preservation
W47.1-03 (R2008)	Certification of Companies for Fusion Welding of Steel
W47.2-M1987 (R2008)	Certification of Companies for Fusion Welding of Aluminum
W59.2-M1991 (R2008)	Welded Aluminum Construction
S6-06	Canadian Highway Bridge Design Code

ASTM International

A 27/A27M-13	Specification for Steel Castings, Carbon, for General Application
A 108-13	Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished
A 123/A123M-12	Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

A 143/A143M-12	Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement
A 153/A153M-12	Zinc Coating (Hot-Dip) on Iron and Steel Hardware
A 307-12	Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength
A 314-13a	Specification for Stainless Steel Billets and Bars for Forging
A 325M-13	Standard Specification for Structural Steel Bolts, Steel, Heat Treated 830MPa Minimum Tensile Strength [Metric]
A 563 - 07a (2014)	Standard Specification for Carbon and Alloy Steel Nuts
A 780/A780M-09	Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
B 108/B108M-12e1	Specification for Aluminum-Alloy Pavement Mold Castings
B 117-11	Standard Practice for Operating Salt Spray (Fog) Apparatus
B 209-10	Specification for Aluminum and Aluminum-Alloy Sheet and Plate
B 221-12	Aluminum and Aluminum-Alloy Extruded bars, Rod, Wire, Shapes and Tubes
B 695-09	Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel
D 4541-09	Test Methods for Pull-Off Strength of Coatings Using Portable Adhesion Testers
F 844 - 07a (2013)	Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use

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.

908.03 DEFINITIONS

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

Barrier Wall Railing means a metal railing that is fastened to the top of a concrete barrier wall and is part of a barrier system that has undergone the barrier appraisal requirements of CAN/CSA-S6.

Bicycle Railing means an all-metal barrier system mounted on a structure that has been designed to meet the bicycle barrier requirements of CAN/CSA-S6.

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.

Metal Traffic Barrier means an all-metal traffic barrier system mounted on a structure that has undergone the barrier appraisal requirements of CAN/CSA-S6.

Parapet Wall Railing means a metal railing that is fastened to the top of a concrete parapet wall and is part of a barrier system that has undergone the barrier appraisal requirements of CAN/CSA-S6.

Pedestrian Railing means an all-metal barrier system mounted on a structure that has been designed to meet the pedestrian barrier requirements of CAN/CSA-S6.

Quality Verification Engineer (QVE) means an Engineer retained by the Contractor qualified to provide the services specified in the Contract Documents.

Railing means a general or generic term for railing and includes barrier wall railing, pedestrian railing, bicycle railing, parapet wall railing, or metal traffic barrier.

908.04 DESIGN AND SUBMISSION REQUIREMENTS

908.04.01 Submission Requirements

908.04.01.01 General

The Contractor shall submit 3 sets of Working Drawings to the Contract Administrator, prior to commencement of fabrication of the railings, 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 consistent with 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 railing or the metal traffic barrier 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 railing fabrication.

The Contractor shall have a sealed and signed copy of the railing Working Drawings at the site prior to and during installation of the railing.

908.04.01.02 Interim Inspection After Fabrication of Railing and Metal Traffic Barrier

Upon completion of fabrication, the Quality Verification Engineer shall conduct an interim inspection of the work to verify that the fabrication of the railing or the metal traffic barrier or both has been carried out according to the Working Drawings and as specified in the Contract Documents, and issue written permission to proceed with the delivery.

908.04.01.03 Test Reports for Fasteners and Anchorages

Proof 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 as specified in the Mill Test Certificates clause of OPSS 906.

908.05 MATERIALS

908.05.01 Metal Traffic Barrier

Materials shall be according to the barrier as specified in the Contract Documents.

908.05.02 Barrier Wall Railing, Parapet Wall Railing, Pedestrian Railing, and Bicycle Railing

908.05.02.01 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 A 307 or ASTM A 325M as specified in the Contract Documents.

Studs shall be according to ASTM A 108. Lock nuts shall be according to ASTM A 563. Washers shall be according to ASTM F 844.

Cast steel posts shall be according to ASTM A 27, Grade 65-35.

Paint shall be as specified in the Contract Documents.

908.05.02.02 Aluminum Railing and Aluminum Posts

Extruded aluminum tubing shall be 6061-T6 or 6351-T6 alloy according to ASTM B 221M.

Aluminum sheet and plate shall be 6061-T6 alloy according to ASTM B 209M.

Cast Posts shall be A444.0-T4 heat-treated according to ASTM B 108. Extruded posts shall be 6061-T6 or 6531-T6.

908.05.02.03 Stainless Steel Fasteners

Bolts, set screws, nuts, and washers shall be Type 304 stainless steel according to ASTM A 314.

908.05.02.04 Hardware - Galvanized

L-bolt assemblies shall be according to ASTM A 307 and include hex nuts, flat washers, and lock washers. The assemblies shall be galvanized according to ASTM A153/A153M.

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 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 railing and metal traffic barrier components shall be according to ASTM A 123/A 123M.

908.05.06 Zinc-Rich Touch-Up Paint

Zinc-rich touch-up paint shall be according to the ministry's DSM.

908.05.07 Thermal Sprayed Metal Coatings

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 General

Railing and metal traffic barrier 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.

908.07.02 Alignment

The railing and metal traffic barriers 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.

908.07.03 Anchorages

908.07.03.01 General

Anchorage assemblies shall be installed as specified in the Contract Documents.

908.07.03.02 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 steel. Anchorage assemblies shall be positioned with templates and installed securely in the formwork to maintain the position of the anchors during placement of concrete.

908.07.03.03**Anchorage Installed After 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 herein. 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 1 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.

908.07.03.04**Anchorage 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.

908.07.04**Fabrication of Railings and Metal Traffic Barriers****908.07.04.01****General**

The railing system and metal traffic barrier components shall be fabricated according to the details specified in the Working Drawings. Field modification shall only be done when approved by the Contract Administrator.

When welding is required, the fabricator shall be certified according to Division 2.1 of CSA W47.1 for steel railings or CSA W47.2 for aluminum railings.

908.07.04.02**Steel Components****908.07.04.02.01****Fabrication****908.07.04.02.01.01****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.

908.07.04.02.02 Surface Preparation for Hot Dip Galvanizing

The railing and metal traffic barrier components shall be cleaned to the requirements of SSPC-SP 8 prior to galvanizing. 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 A 143/A 143M.

908.07.04.02.03 Hot Dip Galvanizing

Hot dipped galvanizing of railings and metal traffic components shall be according to ASTM A 123/A 123M. 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 A 153/A 153M.

908.07.04.02.04 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 B 117.

Lock nuts shall be zinc plated according to ASTM B 695.

908.07.04.02.05 Paint Coating of Galvanized Surfaces

Where specified, paint coating of galvanized surfaces shall be according to OPSS 911.

908.07.04.02.06 Repair of Damage to Galvanized Coating

When the galvanized surface of a railing or metal traffic barrier 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 m², whichever is less. Where the cumulative area exceeds these amounts, the damaged coating shall be stripped and the component re-galvanized according to ASTM A 123/A 123M.

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 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 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 done 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 D 4541.

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 mm², and
- ii. The number of repair spots does not exceed 6 per each 12 m section of galvanized rail bar or metal traffic barrier. 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 A 780/A 780M.

908.07.04.03 Aluminum Components

Aluminum railings and posts shall be thoroughly cleaned of all discolourations 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.

Welding of aluminum shall be permitted only where specified in the Working Drawings.

Inert Gas Shielded Arc (GSA) processes and the quality of the welding shall be according to CSA W59.2-M.

908.07.05 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.

908.07.06 Quality Control

908.07.06.01 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 Contract Documents:

- a) Materials
- b) Fabrication
- c) Installation and adjustments

908.07.07 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

908.09 MEASUREMENT FOR PAYMENT

908.09.01 Actual Measurement

908.09.01.01 Metal Traffic Barrier Barrier Wall Railing Parapet Wall Railing Pedestrian Railing Bicycle Railing

Measurement of railing shall be by length in metres from end to end of railing.

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

Metal Traffic Barrier - Item
Barrier Wall Railing - Item
Parapet Wall Railing - Item
Pedestrian Railing - Item
Bicycle Railing - Item

Payment at the Contract price for the above tender items shall be full compensation for labour, Equipment, and Material to do the work.

Appendix 908-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

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR STRESSING SYSTEMS FOR POST-TENSIONING

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APPENDICES

910-A	Commentary

910.01 SCOPE

This specification covers the construction requirements for post-tensioning and grouting of prestressed concrete.

910.01.01 Specification Significance and Use

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

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 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.

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

Ontario Provincial Standard Specification, Construction

OPSS 905 Steel Reinforcement for Concrete

Ontario Provincial Standard Specification, 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 CAN/CSA S6 for Ontario

Laboratory Testing Manual:
LS-100 Method for Rounding-off of test data and other numbers

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
S6-06 Canadian Highway Bridge Design Code

ASTM International

A 53/A 53M-04a	Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless
D 2239-03	Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter
D 3350-04	Polyethylene Plastics Pipe and Fitting Materials
D 4285-83 (1999)	Indicating Oil or Water in Compressed Air

International Organizations 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 subject to error.

Cementing Materials means as defined in OPSS 1304.

Coupler means a device for the joining of two post-tensioning tendons or bars by means of a mechanical connector.

Grout means an initially fluid mixture of cementing materials, aluminium 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.

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 the injection of 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 DESIGN AND SUBMISSION REQUIREMENTS

910.04.01 Design Requirements

Design shall be according to the CAN/CSA-S6 and the Structural Manual, Division 1.

910.04.02 Submission Requirements

910.04.02.01 General

All Working Drawings, post-tensioning details, and calculations shall bear the seal and signature of an Engineer.

All submissions shall be according to the appropriate clause; however, 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.

At least 5 weeks prior to the commencement of the work, 5 copies of any proposal by the Contractor shall be submitted to the Contract Administrator for acceptance. 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.

The Contract Administrator shall respond to the Contractor within 10 Business Days of receiving the proposal.

910.04.02.02 Post-Tensioning Working Drawings

At least 3 weeks before commencement of the placing of post-tensioning materials, 5 sets of all Working Drawings shall be submitted to the Contract Administrator. These drawings shall include the following:

- a) Design details
- b) Slip
- c) Calculation data
- d) Post-tensioning sequence
- 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, anchorages 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:

- a) Anchorage bulb dimensions
- b) Spacing of bulbs
- c) Length of strand embedded in concrete
- d) Ultimate load capacity of the anchorage

910.04.02.03 Stressing Details

At least 2 weeks prior to commencement of stressing operations, 3 copies of the following information shall be submitted to the Contract Administrator.

- a) Elongation calculations that take into account all relevant losses
- b) The type of jacks
- c) Friction of jacks
- d) Jacking pressure
- e) Method of attaining the required slip
- f) Two copies of the post-tensioning steel manufacturer's stress-strain curves test reports

910.04.02.04 Couplers

At least 3 weeks prior to the 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 that the strength and fatigue requirements have been satisfied shall be submitted to the Contract Administrator.

910.04.02.05 Post-Tensioning 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 at the time the material is shipped from the fabrication plant.

910.04.02.06 Certificate of Compliance

The Certificate of compliance, as prepared according to OPSS 1304 and supplied with the packaged dry grout mixture, shall be submitted to the Contract Administrator prior to commencement of grouting.

910.05 MATERIALS

910.05.01 Ducts

910.05.01.01 General

Ducts for internal post-tensioning shall be formed from bright steel, galvanized steel, or plastic. The ducts, including joints, shall be watertight under an internal pressure of 350 kPa, corrugated, and non-reactive with concrete, tendons, or grout.

Ducts for external post-tensioning shall be made from smooth, rigid polyethylene.

All ducts 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 ducts that are continuous over more than one span. Air and drainage vents shall be provided at other locations as specified in the Contract Documents.

Ducts shall be capable of withstanding concrete pressures without excessive deformations and shall not permit the entrance of cement paste during the placement of concrete. The ducts shall have sufficient rigidity to maintain the required profile between points of support.

For single strand of bar tendons, the inside diameter of the 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 duct shall be at least twice the cross-sectional area of the 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 location of the duct.

910.05.01.02 Steel Ducts

Rigid steel ducts shall have a wall thickness of at least 0.60 mm and shall be capable of being curved to an inside radius of 9 m without distress. Semi-rigid steel ducts shall have a wall thickness of at least 0.25 mm and shall be capable of being curved to an inside radius of 3.5 m without distress.

910.05.01.03 Plastic Ducts

Plastic ducts, 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 ducts shall be treated to resist deterioration from ultraviolet light according to ASTM D 3350 and coded D or E.

The plastic duct shall be manufactured according to ASTM D 2239.

Plastic ducts shall not be used when the specified radius of curvature of the tendon is less than 10 m. The ducts shall be capable of being curved to the specified radius without damage. The duct 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 ducts, the radial force, as exerted on the duct wall by a single strand, shall not exceed 40 kN/m.

The plastic ducts shall be according to the following:

- a) For ducts 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 ducts 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 duct shall not deform more than 3 mm under a point load of 445 N applied through a No. 10 reinforcing steel bar located between the corrugation ribs at a temperature of not less than 20 °C.

Ducts 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 ± 0.25 mm.
 - ii. External ducts shall have an external diameter to wall thickness ratio of 21 or less.

910.05.01.04 Ducts at Deviators

Ducts 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 duct shall be formed to conform to the alignment of the tendon.

910.05.01.05 Vents

Vents shall be a 20 mm minimum diameter flexible tubing material capable of withstanding the applied grouting pressures.

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 tensile strength of the tendons. After tensioning and the initial slip required to seat the strands has occurred, anchorages shall be capable of sustaining the applied loads without additional slippage, distortion, or other changes that could result in unaccounted loss of prestress.

910.05.03.02 Anchorages

The manufacturer of the post-tensioning system establishes the dimensions and details of anchorages within the local zone, which are dependent on the jacking force and the concrete strength at transfer specified in the Contract Documents. Additional steel reinforcement required to resist tensile, bursting, spalling, or longitudinal edge tension forces within the general zone shall be as specified in the Contract Documents.

Primary tendon anchorages shall be provided with steel end caps that cover the strand ends and wedges. The steel cap shall have a 3 mm minimum wall thickness and shall have attachments and gaskets that allow the cap to withstand full grouting pressures. End caps shall be vented to ensure that they are completely filled with grout.

Anchorage for unbonded tendons shall not cause a reduction in the total elongation of the tendon, under ultimate load, greater than 2% measured in a minimum gauge length of 3 m.

910.05.03.03 Couplers

Couplers shall be according to the submitted manufacturer's data that is approved by the Contract Administrator.

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 shall be 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 behaviour 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 could be expected on the anchorage.

910.05.04 Associated Hardware

Only hardware, including spacers and support devices for the ducts, 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 packaged, commercially available grout, according to OPSS 1304. The packaged dry grout mixture shall be stored in dry conditions up to the time of its use and shall be used within one month of packaging.

910.05.07 Grout

The grout shall have the following physical properties:

- a) A 28-Day compressive strength of not less than 60 MPa.
- b) No bleeding or segregation 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.

910.05.08 Water

Water shall be according to OPSS 1302.

910.06 EQUIPMENT

910.06.01 Air Compressor

The air compressor used for air blasting shall have a minimum capacity of 3.5 m³/min. The compressed air shall be free of oil according to ASTM D 4285.

910.06.02 Post-Tensioning

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) The device shall be 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 conversion chart so that the imperial readings can be converted into Newtons.
- c) The indicating dials of the gauges shall be at least 150 mm in diameter.
- d) Each gauge shall be accompanied by a certified calibration curve that bears the seal and signature of an Engineer.
- e) The graduated capacity of the gauge shall such that the forces to be measured fall within 25 and 75% of the minimum and maximum measurement levels respectively, unless calibration data clearly establishes that the gauge is accurate over a wider range.
- f) Pressure gauges shall not fluctuate excessively and shall remain steady until the jacking load is released.
- g) Gauges shall be mounted near eye level and within 2 m of the operator and positioned so readings can be obtained without parallax.
- h) Two gauges shall be used at each jack and pump combination.

910.06.03 Grouting

The grouting equipment shall consist of a mixer, a separate holding tank, and a 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 $\pm 2\%$, shall be accompanied by a certified calibration curve that bears the seal and signature of an Engineer, and shall have been calibrated within the six-month period preceding the 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 valve set to release at a pressure of 1 MPa. The pressure gauge shall have an accuracy of $\pm 2\%$, shall be accompanied by a certified calibration curve that bears the seal and signature of an Engineer, 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 or compressed air, shall be available at the site before commencement of grouting in case of breakdown of the grouting equipment during grouting. Suitable equipment to grout a number of ducts simultaneously shall be readily available.

910.06.04 Grout Testing

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

Malfunctioning gauges shall be replaced immediately upon discovery of the malfunction.

910.07 CONSTRUCTION

910.07.01 General

910.07.01.01 Prestressing Personnel

Staff employed or licensed by the manufacturer of the post-tensioning system shall carry out the work.

Staff employed to supervise the work of tensioning and grouting shall have a working knowledge of the post-tensioning system used and shall be capable of evaluating the forces, gauge pressures, elongations, and method by which the post-tensioning 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, shall be present during the post-tensioning and grouting, and shall also be present during concreting operations to ensure that the post-tensioning components of the work are not adversely affected.

910.07.01.02 Welding

Welding within 3 m of the post-tensioning steel is not permitted and welding equipment shall not use any components of the post-tensioning system as an electrical ground.

Welding of the prestressing tendons shall only be permitted to facilitate pulling the tendon through the duct. Where the ends of strands are welded together to facilitate pulling the tendon through the duct, 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. No other welding of post-tensioning tendons and ducts is permitted.

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 Installation

910.07.02.01 Post-Tensioning System

Post-tensioning steel, ducts, anchorages, couplers, and local steel reinforcement at anchorages shall be placed in the position shown in the Contract Documents and shall be held in the correct location during the operations of placing and consolidating of concrete.

The ducts shall be supported and secured at intervals not exceeding 1 m and a smooth profile shall be maintained. All joints between ducts and ducts 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 placement of concrete.

Ducts and anchorages shall be placed according to the Contract Documents and within the following vertical and horizontal tolerances:

- a) Longitudinal sheath ± 15 mm.
- b) Transverse sheath ± 10 mm.
- c) Anchorage ± 10 mm.

Couplers for strand or high strength bar 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 post-tensioning system used.

Upon completion of the placement of the post-tensioning system, including all anchorages, anchorage zone reinforcement, and grout tubes, the Quality Verification Engineer shall make an interim inspection of the work to verify that the post-tensioning system meets the requirements of and has been placed as specified in the Contract Documents. The quality Verification Engineer shall then issue written permission to proceed with the post-tensioning.

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. Duct holes at vent locations shall be of the same size as the inside diameter of the vent tube.

910.07.02.03 Steel Reinforcement

The placing of steel reinforcement as duct support bars, spirals, tensioning rings, and reinforcing grids at anchorages shall be according to OPSS 905.

910.07.03 Post-Tensioning

910.07.03.01 General

The Contract Administrator shall be notified when the post-tensioning steel is available for sampling at least 1 week in advance of stressing.

Post-tensioning 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

The Quality Verification Engineer shall witness the stressing to verify that it is carried out according to the signed and sealed Working Drawings and Stressing Details and issue written permission to proceed with grouting.

910.07.03.02 Material Samples

Samples of post-tensioning materials and the 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 shall 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 reached the strength specified in the Contract Documents.

Post-tensioning shall be carried out according to the Contract Documents and the Working Drawings.

After tensioning, all openings and vents along the post-tensioning system shall be temporarily plugged or sealed until grouting commences.

910.07.03.04 Measurement of Tensioning and Variation in the Post-Tensioning Force

Friction losses in jacks, hoses, and connections shall be determined and recorded. The force in the tendons shall be determined by means of the pressure gauge and shall be continually verified by measuring the tendon elongation. The pressure gauge readings and the elongations shall be recorded at intervals of 25% of the maximum force and shall include the final reading.

The measured elongations of individual tendons, at the specified jacking force and based on the gauge pressures, shall be within -3 to $+9\%$ of the calculated values. If the actual elongation is outside this tolerance, jacking of that tendon shall stop and the Contractor shall prepare and submit a report rationalizing the observed difference.

The variation from the specified total post-tensioning force over the entire component cross-section, including any broken strands, shall not exceed $\pm 5\%$. The distribution of the variation of the total post-tensioning force across the component cross-section shall be subject to the approval of the Contract Administrator.

The gauges shall be recalibrated any time a gauging system indicates erratic results and at intervals not greater than six months.

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 Post-Tensioning Records

Upon completion of all post-tensioning operations, the Contractor shall submit to the Contract Administrator, records of elongation, calibrated jacking pressure readings, slippages, and strand breakages.

910.07.03.07 Cutting of Tendons

Tendons shall not be cut back until the Contractor has received written permission from the Quality Verification Engineer to proceed with the grouting. Care shall be exercised at all times in the cutting of tendons to avoid the possibility of adversely affecting the prestressing steel.

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 written permission to proceed with the grouting has been given by the Quality Verification Engineer. Once written permission has been given, grouting shall be carried out as soon as possible, but in no case shall any post-tensioning ducts be left ungrouted for more than 7 Days from the date written permission was given or more than 14 Days from the time of completion of stressing.

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 that 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 injection 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 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.
- 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 interval between the addition of the dry grout 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 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 nor 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 at that level, or higher, for at least 72 hours after grouting has been completed.

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 of the same consistency as that being pumped into the injection vent. When the grout is of the same consistency, an additional 5 litres of grout shall be allowed 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 reopened, 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 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 minimum compressive strength of 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.

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. This staff shall also prepare the test cubes.

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 Quality Verification Engineer, a trial batch of grout shall be mixed and tested according to CSA A23.2-1B for bleeding, expansion, and viscosity to ensure that the grout meets the requirements specified herein. 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 from the mixer. The grout tests shall be performed at least once a day and as requested by the Contract Administrator.

Copies of the results of the bleeding, expansion, and viscosity tests shall be submitted to the Contract Administrator. Any test result that indicates the grout is not meeting the requirements specified herein shall be immediately reported to the Contract Administrator and the grouting operation shall be halted. The duct being grouted shall immediately be flushed with clean water and then blown out with dry, oil free compressed air. Grouting shall recommence only after the problem has been 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 subplot 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 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 compressive strength of 20 MPa.

The laboratory conducting the early compressive strength tests shall be CSA certified as specified herein.

910.07.06 Prestressing Steel Friction Test

Where the theoretical and actual elongations are significantly different, the Quality Verification Engineer may call for 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 Certificate of Conformance

Upon completion of grouting, the Contractor shall submit to the Contract Administrator a Certificate of Conformance sealed and signed by a Quality Verification Engineer. The Certificate of Conformance shall state that the placement, stressing, and grouting of the post-tensioning system have been carried out as specified in the Contract Documents.

910.07.09 Management of Excess Material

Management of excess material shall be as specified in the Contract Documents.

910.08 QUALITY ASSURANCE

910.08.01 Grout

When requested, representative samples of the packaged grouting material shall be submitted to the Contract Administrator.

910.08.02 Acceptance Based on Compressive Strength

The total volume of grout used for grouting one structure represents one lot. Each lot shall be divided into sublots with a minimum of four subplot results in each lot. A subplot shall be represented by an average of six 28-Day compressive strength results sampled from one batch of grout. The individual compressive strength results shall be rounded to one decimal place.

Acceptance of the compressive strength for each lot shall be based on the mean and the standard deviation of the lot measurements calculated by the Contract Administrator as detailed in the Payment Adjustment Section.

Lots with per cent within limits (PWL) greater than 98% shall be accepted with a bonus payment. Lots with PWL equal to or greater than 90% and lower than or equal to 98% shall receive full payment, and lots where the PWL is less than 90% shall be accepted at a reduced payment.

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 Materials to do the work.

910.10.01.01 Payment Adjustment Based on Compressive Strength of Grout

The payment adjustment factor for the Contract price for longitudinal and transverse stressing systems shall be determined as follows.

Acceptance formula:

The quality index for the lower specification limit, Q_L , shall be determined from the following formula:

$$Q_L = (X - 60) / s$$

Where: X is the Mean
s is the Standard Deviation

The mean shall be rounded to one, and the standard deviation and lower quality index shall be rounded to two decimal places. The rounding procedure shall be according to LS-100.

The PWL shall be determined from Table 1 based on the Lower Quality Index (Q_L) and using the number of sublots (n).

The payment adjustment factor corresponding to the PWL shall be determined from Table 1. The payment adjustment factor shall apply down to a minimum of 70% of the Contract price for longitudinal and transverse stressing systems for the lot.

910.10.02 Concrete

Concrete for the anchorage recesses shall be paid according to OPSS 904.

Table 1
Quality Index Values for Estimating Per Cent Within Limits and Payment Adjustment Factor

PWL	n=4	n=5	n=6	n=7	n=8	n=9	n=10	n=11	n=12	n=15	Payment
100	1.50	1.79	2.03	2.23	2.39	2.53	2.65	2.65	2.83	3.03	1.02
99	1.47	1.67	1.80	1.89	1.95	2.00	2.04	2.04	2.09	2.14	1.01
98	1.44	1.60	1.70	1.76	1.81	1.84	1.86	1.86	1.91	1.93	1.00
97	1.41	1.54	1.62	1.67	1.70	1.72	1.74	1.74	1.77	1.80	1.00
96	1.38	1.49	1.55	1.59	1.61	1.63	1.65	1.65	1.67	1.69	1.00
95	1.35	1.44	1.49	1.52	1.54	1.55	1.56	1.56	1.58	1.59	1.00
94	1.32	1.39	1.43	1.46	1.47	1.48	1.49	1.49	1.50	1.51	1.00
93	1.29	1.35	1.38	1.40	1.41	1.42	1.43	1.43	1.44	1.44	1.00
92	1.26	1.31	1.33	1.35	1.36	1.36	1.37	1.37	1.37	1.38	1.00
91	1.23	1.27	1.29	1.30	1.30	1.31	1.31	1.31	1.32	1.32	1.00
90	1.20	1.23	1.24	1.25	1.25	1.26	1.26	1.26	1.26	1.27	1.00
89	1.17	1.19	1.20	1.20	1.21	1.21	1.21	1.21	1.21	1.22	0.99
88	1.14	1.15	1.16	1.16	1.16	1.17	1.17	1.17	1.17	1.17	0.98
87	1.11	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.13	0.97
86	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	0.96
85	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	0.95
84	1.02	1.01	1.01	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.94
83	0.99	0.98	0.97	0.97	0.96	0.96	0.96	0.96	0.96	0.96	0.93
82	0.96	0.95	0.94	0.93	0.93	0.93	0.92	0.92	0.92	0.92	0.92
81	0.93	0.91	0.90	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.91
80	0.90	0.88	0.87	0.86	0.86	0.86	0.85	0.85	0.85	0.85	0.90
79	0.87	0.85	0.84	0.83	0.82	0.82	0.82	0.82	0.82	0.82	0.89
78	0.84	0.82	0.80	0.80	0.79	0.79	0.79	0.79	0.78	0.78	0.88
77	0.81	0.78	0.77	0.76	0.76	0.76	0.75	0.75	0.75	0.75	0.87
76	0.78	0.75	0.74	0.73	0.73	0.72	0.72	0.72	0.72	0.72	0.86
75	0.75	0.72	0.71	0.70	0.70	0.69	0.69	0.69	0.69	0.69	0.85
74	0.72	0.69	0.68	0.67	0.66	0.66	0.66	0.66	0.66	0.66	0.84
73	0.69	0.66	0.65	0.64	0.63	0.63	0.63	0.63	0.62	0.62	0.83
72	0.66	0.63	0.62	0.61	0.60	0.60	0.60	0.60	0.59	0.59	0.82
71	0.63	0.60	0.59	0.58	0.57	0.57	0.57	0.57	0.57	0.56	0.81
70	0.60	0.57	0.56	0.55	0.55	0.54	0.54	0.54	0.54	0.54	0.80
69	0.57	0.54	0.53	0.52	0.52	0.51	0.51	0.51	0.51	0.51	0.79
68	0.54	0.51	0.50	0.49	0.49	0.48	0.48	0.48	0.48	0.48	0.78
67	0.51	0.47	0.47	0.46	0.46	0.46	0.45	0.45	0.45	0.45	0.77
66	0.48	0.45	0.44	0.44	0.43	0.43	0.43	0.43	0.42	0.42	0.76
65	0.45	0.43	0.41	0.41	0.40	0.40	0.40	0.40	0.40	0.40	0.75
64	0.42	0.40	0.39	0.38	0.38	0.37	0.37	0.37	0.37	0.37	0.74
63	0.39	0.37	0.36	0.35	0.35	0.35	0.34	0.34	0.34	0.34	0.73
62	0.36	0.34	0.33	0.32	0.32	0.32	0.32	0.32	0.31	0.31	0.72
61	0.33	0.31	0.30	0.30	0.29	0.29	0.29	0.29	0.29	0.29	0.71
60	0.30	0.28	0.27	0.27	0.27	0.26	0.26	0.26	0.26	0.25	0.70

Appendix 910-A, April 2008
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 COATING STRUCTURAL STEEL SYSTEMS

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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 is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

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 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.

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

S6-06 Canadian Highway Bridge Design Code

ASTM International

A 123/A123M-12	Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
A143/A143M-07	Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement
A153/A153M-09	Zinc Coating (Hot-Dip) on Iron and Steel Hardware

A 780/A780M-09	Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
B 833-13	Standard Specification for Zinc and Zinc Alloy Wire for Thermal Spraying (Metallizing) for the Corrosion Protection of Steel
C 566-13	Test Method for Total Evaporable Moisture Content of Aggregate by Drying
D 4285-83 (2012)	Test Method for Indicating Oil or Water in Compressed Air
D 4417-11	Test Methods for Field Measurement of Surface Profile of Blast Cleaned Steel
D 4541-09	Test Methods for Pull-Off Strength of Coatings Using Portable Adhesion Testers
D 4940-10	Test Methods for Conductimetric Analysis of Water Soluble Ionic Contamination of Blasting Abrasives
D 6386-10	Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting
D 7091-12	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)

Good Painting Practice, SSPC Painting Manual Vol.1, 4th Edition, 2002

AB 1, April 2013	Mineral and Slag Abrasives
PA 1, November 2004	Shop, Field, and Maintenance Painting of Steel
PA 2, May 2012	Procedure for Determining Conformance to Dry Coating Thickness Requirements
SP 1, November 2004	Solvent Cleaning
SP 8, November 2004	Pickling
SP 11, July 2012	Power Tool Cleaning to Bare Metal
VIS 1-02	Visual Standard for Abrasive Blast Cleaned Steel
VIS 3-04	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

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

Others

Federal Standard 595C Colors, 2008 - 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 Washing 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 CAN/CSA-S6, Structural Manual, and OPSS 919.

911.04.02 Submission Requirements

911.04.02.01 General

Except for the material certification for the coating material, 5 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, erection 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 that the Contractor requires to support the enclosure system can safely support all loads, including construction loads according to CAN/CSA-S6 and the 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 CAN/CSA-S6 and the Structural Manual, including construction loads imposed on the bridge based on the Contractor's 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 six 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

Where specified in the Contract Documents, one of the approved paint systems for coating galvanized surfaces from the ministry's 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, unless otherwise specified.

D911.05.01.03 Rapid Deployment Coating Systems for Structural Steel

Where specified in the Contract Documents, one of the approved paint systems for rapid deployment coating systems from the ministry's 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 A 123/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 included on the ministry's 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 included on the ministry's 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 B 833

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 D 4940.

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 C 566.

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 D 4285.

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.

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.

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 Contractor's 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 D 6386.

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 A123/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 A143/A143M.

911.07.03.07 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 Contractor's 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 by the Contractor 48 hours in advance of mixing and applying a paint coating or coating system.

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 A 325 bolts to be used on coated areas of structural steel after the application of coating 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.

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.

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.

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. Faying surfaces of bolted joints shall have only the prime coat applied.

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 10 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 erection shall be coated prior to erection.

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 10 hours.

When work operations require bolt connections of structural steel components, faying surfaces of exiting 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 4 hours.

911.07.04.02.05 Slip Critical Connections

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.

911.07.04.02.06 Dry Film Thickness

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.

911.07.04.02.07 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 cm², 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.

911.07.04.02.08 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 A123/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 A153/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 metres.

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 Contractor's 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 D 4541 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 6 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 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 of damaged and uncoated areas and the application of the flux and zinc-tin-copper solder shall be according to ASTM A 780 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 D 4541 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 6 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 mm²,
- 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 6 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 ministry's DSM shall be used for repair of galvanized coating defects on overhead trusses.

Only the epoxy zinc primer listed on the ministry's 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 Contractor's 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 one week from the date of sampling for testing to:

Head, Concrete Section
Ontario Ministry of Transportation
Room 15, Building C
1201 Wilson Avenue
Downsview, Ontario, M3M 1J8

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 by the Contractor.

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 D 7091 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, the Contractor may provide an uncoated 300 x 300 mm reference plate sample of steel of similar composition; thickness, $\pm 10\%$; and surface preparation 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 8 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 one 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 the Contractor parks or stores any equipment or materials 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 D 4417, 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 D 7091 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 D 7091 and SSPC-PA 2, except that 5 separate spot measurements at representative locations of each galvanized sign support columns or legs and each sectional steel high mast lighting pole, as determined by the Contract Administrator, 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 D 4541 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 m², 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, as defined by SSPC Painting Manual, Volume 1, Good Painting Practice, Fourth Edition, 2002, pp. 553-567:

- 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 eight 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 five 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 2 coat systems 70% for 3 coat systems
2 nd coat	15% for 2 coat systems 10% for 3 coat systems
3 rd coat	15% for 3 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 erection	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 erection	15%
Cleanup and final coating repair after erection	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	90
Second	90
Third	90

TABLE 2
Epoxy-Zinc, Epoxy, Polyurethane Coating System

Coat	Dry Film Minimum Thickness µm
Prime	90
Second	100
Third	50

TABLE 3
Inorganic-Zinc, Water-Based Acrylic, Water-Based Acrylic Coating System

Coat	Dry Film Minimum Thickness µm
Prime	75
Second	90
Third	90

TABLE 4
Inorganic-Zinc, Epoxy, Polyurethane Coating System

Coat	Dry Film Minimum Thickness µm
Prime	75
Second	100
Third	50

TABLE 5
Three-Coat Moisture-Cured Polyurethane Coating System with Zinc-Rich Primer

Coat	Dry Film Minimum Thickness µm
Prime	90
Second	100
Third	50

TABLE 6
Coal Tar Epoxy Coating System

Coat	Dry Film Minimum Thickness µm
Prime	200
Second	200

TABLE 7
Paint Coating Systems for Coating Galvanized Surfaces

Coat	Dry Film Minimum Thickness µm
High Build Epoxy Prime Coat	100
Aliphatic Polyurethane Topcoat	75
Modified Aluminum Epoxy Mastic Prime Coat	125
Aliphatic Polyurethane Topcoat	50

Appendix 911-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

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



**CONSTRUCTION SPECIFICATION FOR
WATERPROOFING BRIDGE DECKS
WITH HOT APPLIED ASPHALT MEMBRANE**

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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 provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

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 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.

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, Dampproofing and Waterproofing

ASTM International

D 4285-83 (2012)	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.

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.

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 a product recommended by the tack coat manufacturer. The primer shall be according to 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

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. Heating shall be controlled by a thermostat to maintain the temperature of the product used within the range required by the manufacturer.

914.06.02 Thermometer

A separate calibrated thermometer with an accuracy of ± 2 °C for verification of 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 waterproofing membrane reinforcement.
- e) Application of the protection board.
- f) Forming and filling of grooves where there are no separate tender items for this work.
- g) If applicable, repair of rejectable or marginal lots.

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.

Waterproofing membrane reinforcement and protection board shall be stored at the manufacturer's recommended temperature range.

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

Waterproofing membrane applicators shall be from the Owner's list of applicators approved by the waterproofing membrane manufacturer.

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 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 existing waterproofing material shall be removed and all concrete surfaces prepared according to 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 a rate of 0.25 l/m^2 or as required by the manufacturer 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 $5 \pm 1 \text{ mm}$. 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 $12 \pm 6 \text{ mm}$. 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 so 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 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**Sampling for Quality Assurance****914.07.08.01****Material Samples**

Representative samples of the following shall be taken for quality assurance testing by the Owner:

- a) For each lot, as defined in the Quality Assurance section of this specification, a 4 litre sample of waterproofing membrane from the heating and mixing kettle, at the time directed by the Contract Administrator.
- b) For each Contract, a 1 litre sample of tack coat.
- c) For each Contract, a 300 x 300 mm piece of waterproofing membrane reinforcement.
- d) For each Contract, a 300 x 300 mm piece of protection board.
- e) For each Contract, a 1 litre sample of joint sealing compound.

The time of sampling shall be determined using the Field Guide for the Acceptance of Hot Mix and Bridge Deck Waterproofing.

The Contract Administrator shall be allowed to examine the sample containers prior to sampling to ensure they are clean and free of debris.

914.07.08.02 Delivery of Samples

Samples of the waterproofing membrane, waterproofing membrane reinforcement, joint sealing compound, tack coat, and the protection board shall be delivered within 5 Business Days of the application date to:

Head, Concrete Section
Ontario Ministry of Transportation
Room 15, Building C
1201 Wilson Avenue
Downsview, Ontario, M3M 1J8

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 Lot Size

A lot size shall be a single bridge deck or part of a bridge deck with a surface area of 800 m² or less. Decks larger than 800 m² shall be divided into the least number of equal size lots of 800 m² or less. Decks separated into segments for staged construction shall be treated as separate lots. The Contract Administrator shall determine the limits of each lot.

For measurement of membrane thickness only, a lot shall be divided into 10 equal sublots. The sampling location within the subplot shall be determined by the Contract Administrator.

914.08.02 Acceptance of Waterproofing Membrane Reinforcement, Joint Sealing Compound, and Tack Coat

Waterproofing membrane reinforcement, joint sealing compound, and tack coat shall be evaluated by the Owner for compliance with the requirements of this specification.

914.08.03 Acceptance of Waterproofing Membrane Thickness

914.08.03.01 General

The Contract Administrator shall determine the acceptability of the waterproofing membrane thickness by measurement on a lot-by-lot basis.

914.08.03.02 Testing of Waterproofing Membrane Thickness

Measurements shall be made according to the Field Guide For the Acceptance of Hot Mix and Bridge Deck Waterproofing and shall be taken after each lot has been completed, including the placement of protection board.

914.08.03.03 Waterproofing Membrane Thickness Acceptance Determination

The decision to accept the waterproofing membrane thickness shall be based on the mean and standard deviation of each lot.

If the lot mean is less than 4.0 mm or greater than 6.0 mm, the entire lot is rejectable and the Contractor shall remove and replace the lot according to the Treatment of Rejectable Lots clause.

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, marginal, or rejectable range. If the lot is within the marginal 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 rejectable range as shown in Table 1, the Contractor shall remove and replace the lot according to the Treatment of Rejectable Lots clause.

Where the membrane thickness is greater than 6.0 mm, the Contractor may submit a proposal in writing for an alternative to removal and replacement for rejectable waterproofing membrane thickness for the Owner's consideration.

914.08.03.04 Referee Testing of Waterproofing Membrane Thickness for Marginal or Rejectable Lots

The Contractor may request retesting, prior to paving and within 2 Business Days of being advised of test results, if any or all of the 10 subplot 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.

If the referee testing results in either a marginal or a rejectable lot, the Contractor shall bear the cost of the referee testing. If the referee testing results in the material passing thickness testing criteria and resulting in an acceptable lot, the referee testing charge shall be paid by the Owner.

914.08.04 Acceptance of Waterproofing Membrane Quality

914.08.04.01 General

Acceptance of the waterproofing membrane quality shall be on a lot-by-lot basis.

914.08.04.02 Sampling and Testing of Waterproofing Membrane Quality

The sample delivered to the Owner shall be split at the laboratory into 2 equal parts; one part shall be tested for acceptance and the other shall be retained for referee testing.

914.08.04.03 Waterproofing Membrane Quality Acceptance Determination

A lot shall be acceptable if it meets the requirements as shown in Table 2 when tested in accordance with OPSS 1213 and this specification. Marginal lots shall be subject to a payment adjustment according to this specification.

A lot is rejectable if any of the following criteria are met:

- a) The total number of adjustment points (PT), as shown in Table 2 is greater than 20.
- b) Any test result for a sample is in the rejection value range, as shown in Table 2.

A lot shall be considered marginal and subject to a payment adjustment as outlined in the Payment Adjustment Due to Membrane Quality Deficiency clause if the total number of adjustment points (PT) resulting from Table 2 is greater than zero and less than or equal to 20.

Rejectable lots shall be removed and replaced according to the Treatment of Rejectable Lots clause.

914.08.04.04**Referee Testing of Waterproofing Membrane Quality**

The Contractor may request, in writing, retesting of any sample that results in payment adjustment or rejection of a lot; however, the request shall be made within 5 Business Days of receiving notification of payment adjustment or rejection of the lot. The results of the referee test shall be used for acceptance determination and shall be binding on both parties. If the referee testing results in either a payment adjustment or rejection of the lot, the Contractor shall bear the cost of the referee testing. If the referee testing results in the material passing all test criteria, the referee testing charge shall be paid by the Owner.

914.08.05**Acceptance of Protection Board**

Protection board shall be acceptable if it meets the requirements of OPSS 1215 and this specification.

The Contract Administrator shall determine acceptability of protection board thickness on a lot-by-lot basis. A lot size shall be the total number protection boards required to cover the area defined in the Lot Size clause.

One protection board per lot shall be randomly selected by the Contract Administrator and the thickness shall be measured according to the Field Guide for the Acceptance of Hot Mix and Bridge Deck Waterproofing. Protection board thickness measurement shall be done on site prior to the commencement of the waterproofing operation.

Lots where the measured protection board thickness is less than 3.2 mm or greater than 4.0 mm shall be rejectable.

Rejectable protection board shall not be placed in the work. Rejectable protection board that has been placed in the work shall be removed and replaced, along with the waterproofing membrane according to the Treatment of Rejectable Lots clause.

914.08.06**Treatment of Rejectable Lots**

Removal of membrane material shall include removal of the full membrane thickness to neat lines and removal of overlying pavement, as applicable. Deck surface preparation, placement of a new tack coat, membrane material, and membrane reinforcement over the removal area shall be completed according to this specification. New membrane material shall be lapped according to the Application of Waterproofing Membrane clause.

Any protection boards that are removed during the repairs and referee testing shall be replaced with new ones.

Lots that have been repaired or replaced shall be subject to Quality Assurance acceptance requirements of this section.

The Contractor shall be responsible for all costs associated with removing and replacing rejectable lots.

914.09**MEASUREMENT FOR PAYMENT****914.09.01****Actual Measurement****914.09.01.01****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.

914.09.01.02 Form and Fill Grooves

Measurement of forming and filling grooves shall be by length in metres.

914.09.01.03 Modification of Deck Drains

For measurement purposes, a count shall be made of the number of deck drains modified, regardless of type and size.

914.09.01.04 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 thickness adjustment factor of 1.00 shall be applied to the Contract price for the lot.

When a lot is within the marginal range as shown in Table 1 and the Contractor requests that the Owner accept the lot as is, the thickness adjustment factor as shown in Table 1 shall be applied. Where a lot with mean thickness greater than 6.0 mm has been deemed acceptable and the Contractor requests that the Owner accept the lot as is, a payment adjustment factor of 0.60 shall be applied due to membrane thickness deficiency.

914.10.01.02 Payment Adjustment Due to Membrane Quality Deficiency

Quality adjustment factors are calculated as follows:

If any individual test result is inside the rejection value range, the lot is rejectable.

If the sample test results are in the marginal range for one or more tests, the adjustment points as shown in Table 2 for each borderline test result shall be totalled. If the total exceeds 20, the lot is rejectable. If the total is less than or equal to 20, the Contract Administrator shall assign a payment adjustment factor which shall be 100 minus the total of all the adjustment points (PT) and the result divided by 100.

If the sample test results meet all specification limits as shown in Table 2, the Contract Administrator shall assign a payment adjustment factor of 1.00.

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 Mean														
		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		
Lot Standard Deviation	0.0														0.0	Lot Standard Deviation
	.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	Rej	.86	.95	.99	Acc									.65	
	.70	Rej	.59	.87	.96	.99	Acc								.70	
	.75		Rej	.71	.89	.96	.99	Acc							.75	
	.80			Rej	.76	.91	.96	.99	Acc						.80	
	.85				Rej	.81	.91	.96	.99	Acc	Acc				.85	
	.90					Rej	.83	.92	.97	.99	.99	Acc			.90	
	.95					Rej	.64	.84	.93	.97	.99	.99	Acc		.95	
	1.00						Rej	.71	.87	.93	.97	.99	.99	Acc	1.00	

Continues on Next Page

TABLE 1 (Cont'd)
Acceptance Determination and Payment Adjustment Factors Membrane

		Lot Mean																
		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		
Lot Standard Deviation	1.05	Rej	.76	.87	.94	.97	.99	.99	Acc								1.05	Lot Standard Deviation
	1.10		Rej	.79	.89	.94	.97	.99	.99	Acc							1.10	
	1.15		Rej	.59	.81	.90	.95	.97	.99	.99	Acc						1.15	
	1.20			Rej	.64	.83	.91	.95	.97	.99	Acc						1.20	
	1.25				Rej	.71	.84	.91	.95	.97	.99	Acc					1.25	
	1.30					Rej	.76	.86	.92	.95	.97	.99	Acc				1.30	
	1.35						Rej	.77	.87	.92	.95	.98	.99	.99	Acc		1.35	
	1.40						Rej	.59	.79	.87	.93	.96	.98	.99	.99	Acc	1.40	
	1.45							Rej	.68	.82	.88	.93	.96	.98	.99	.99	1.45	
	1.50								Rej	.71	.83	.89	.93	.96	.98	.99	1.50	
	1.55									Rej	.74	.84	.90	.94	.96	.98	1.55	
	1.60										Rej	.78	.86	.91	.94	.96	1.60	
	1.65										Rej	.64	.79	.87	.91	.94	1.65	
	1.70											Rej	.68	.81	.87	.91	1.70	
	1.75												Rej	.71	.82	.87	1.75	
1.80													Rej	.74	.83	1.80		
1.85													Rej	.59	.76	1.85		
1.90														Rej	.64	1.90		
1.95															Rej	1.95		
2.00															Rej	2.00		
Notes:																		
A. Cells containing the Payment Adjustment Factors form the marginal range.																		
B. "Acc" means acceptable.																		
C. "Rej" means rejectable.																		

TABLE 2
Acceptance Determination and Payment Adjustment Factors Membrane Quality

Test	Specification Limits	Marginal Range (B)	Adjustment Points	Rejection Value
Low Temperature Flexibility at -25 °C	Pass	N/A	N/A	Fail
Cone Penetration at 25 °C (0.1 mm)	Max. 110	111 to 130	$P1 = 0.4*(B-110)$	> 130
Cone Penetration at 50 °C (0.1 mm)	Max. 160	161 to 180	$P2 = 0.4*(B-160)$	> 180
Flow at 60 °C (mm)	Max. 3 mm	3.1 to 5.0	$P3 = 4*(B-3)$	> 5
Toughness (joules)	Min. 5.5	5.4 to 4.0	$P4 = 5*(5.5-B)$	< 4.0
Toughness/Peak Load (joules/newton)	Min. 0.040	0.039 to 0.030	$P5 = 500*(0.040-B)$	< 0.030
$PT = P1 + P2 + P3 + P4 + P5$				
Note: A. B is an observed test result within the marginal range to be used for calculation of adjustment points.				

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

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR SIGN SUPPORT STRUCTURES

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915.01 SCOPE

This specification covers the requirements for the design and construction of the tri-chord, cantilever tri-chord, cantilever, variable message, pole mounted 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 provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

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 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.

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
W59-13	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-6	Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, 6 th Edition.

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, 2 nd 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.

Cantilever 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 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.

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.

Pole Mounted Variable Message Sign Support Structure means an overhead sign support structure consisting of a variable message board centre mounted to a single vertical galvanized steel pole.

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 2 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-6, 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 G40.20/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 ± 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. 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:

$$(\text{Total Length of Member in Metres} / 15) \times 10.4 \text{ mm}$$

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, including the anchorage assembly, shall be hot dip galvanized according to OPSS 911.

Legs of sign supports only, shall be subsequently coated with an approved paint system 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 of tri-chord, cantilever tri-chord, cantilever, pole mounted variable message, and 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 mm 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 ± 50 mm.

Height of signboard attachment holes shall be ± 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 the locations specified in the Contract Documents using fasteners appropriate for the application.

All signboards, overlays, and tabs to be installed on all new sign support structures will be supplied by the ministry.

Tabs and overlays placed on signboards shall be installed with self-tapping screws, #3 Teks screws, with a minimum distance between screws of 30 cm.

915.07.06.01 Sign Ordering

A list of required signboards, overlays, and tabs shall be submitted to the Contract Administrator a minimum of 12 weeks prior to the date of installation and shall contain the quantity, sign details, and the date for pick-up.

915.07.06.02 Sign Pick-Up

All ordered signboards, overlays, and tabs shall be picked up at the location provided 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.

915.07.06.03 Sign Confirmation and Inspection

Confirmation in writing shall be provided to the Contract Administrator within 5 Business Days stating that all the supplied signs were received according to the list of required signboards, overlays, and tabs. The Owner shall be responsible for the cost of replacing 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.

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.

915.07.07.01.01 Inspection and Testing Reports

The Contractor shall submit 4 copies of all inspection and testing reports to the Contract Administrator within 7 Days after inspection.

Inspection reports shall bear the seal and signature of an Engineer.

915.07.07.02 Fabrication, Inspection, and Testing

Prior to fabrication, the materials used shall be certified to be according to the requirements specified in the Material section.

Upon completion of fabrication, all welds in the structure shall be visually inspected and the following welds and connections shall be tested to confirm the acceptability of the fabrication:

- a) The following steel connections shall be tested by magnetic particle testing:
 - i. All column to base plate, stiffeners to column, and stiffeners to base plate for the cantilever, tri-chord, cantilever tri-chord, variable message, pole mounted variable message, and overhead monotube sign support structures.
 - ii. All arm to leg connection plates, stiffeners to arm connection plate, and stiffeners to leg connection plate for cantilever and cantilever tri-chord sign support structures.
- b) The following welds shall be tested using ultrasonic testing methods:
 - i. All longitudinal groove welds in the first 2 m of the leg measured from the base plate of the tri-chord, pole mounted variable message, and overhead monotube sign support structures.
 - ii. All longitudinal groove welds along the full length of the legs of cantilever tri-chord and cantilever sign support structures.
 - iii. All circumferential welds.
 - iv. All full penetration groove welds at the 8 inclined chord / horizontal aluminum chord node locations of the end panels of variable message sign support structures.

Upon completion of the galvanizing of tri-chord, cantilever tri-chord, and cantilever sign support structures; the truss portion of the structure shall be visually inspected to confirm that the elements have not been damaged due to the galvanization process.

A written inspection and testing report shall be prepared.

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 prepared.

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 shall be prepared.

915.07.07.04 Coating Inspection

Coating inspection shall be according to OPSS 911.

A written inspection report of the observations shall be prepared.

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.

For tri-chord, cantilever tri-chord, and cantilever static sign support structures only, the interim inspection shall include inspection after galvanizing.

After the interim inspection, the Engineer shall 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 signboards, overlays and tabs 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**
 - Cantilever Tri-Chord Static Sign Support Structures, Class - 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**
 - Pole Mounted Variable Message Sign Support Structures - 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 Signboards - 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

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



**CONSTRUCTION SPECIFICATION FOR
DECK JOINT ASSEMBLIES, PREFORMED SEALS,
JOINT FILLERS, JOINT SEALS, JOINT SEALING COMPOUNDS,
AND WATERSTOPS - STRUCTURES**

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920.01 SCOPE

This specification covers the requirements for 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 is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of 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 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.

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 928	Structure Rehabilitation-Concrete Removal
OPSS 929	Abrasive Blast Cleaning - Concrete Construction
OPSS 930	Structure Rehabilitation-Concrete Patches, Concrete Refacing, and Overlays

Ontario Provincial Standard Specifications, Material

OPSS 1004	Aggregate - Miscellaneous
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-05a	Standard Specification for Chemical Admixtures for Concrete
C 1017M-07	Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete
D 1056-07	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 the expansion joint angle at the gap.

Bearing means a structural device that transmits load while permitting translation or rotation or both.

Blockout means a cavity created to permit the installation of deck joint assemblies.

Elastomer means a compound containing virgin polychloroprene (neoprene).

Joint Seal means ethyl vinyl acetate foam.

Joint Sealing Compound means a hot applied material, which is not preformed, used to seal a joint.

Nosing Angle means the angle that forms the outside edges of the blockout.

Preformed Seal means an extruded elastomer that, when retained in recesses in the deck joint assembly, prevents the passage of water and other materials.

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 Submission Requirements

920.04.01.01 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.

920.04.01.02 Deck Joint Assembly Working Drawings

920.04.01.02.01 General

The Contractor shall submit to the Contract Administrator 3 sets of deck joint assembly Working Drawings prior to commencement of fabrication of the deck joint assembly, for information purposes only. An Engineer shall affix his or her seal and signature on the deck joint assembly Working Drawings verifying that the drawings are consistent with the Contract Documents and sound engineering practices. In addition, for modular joints, the deck joint assembly Working Drawings shall also bear the seal and signature of a design-checking Engineer.

The deck joint assembly manufacturer shall not commence fabrication of the joint assembly until the deck joint assembly Working Drawings have been sealed and signed. A copy of these drawings shall be retained at the manufacturing plant during the joint assembly fabrication.

The Contractor shall have a copy of the deck joint assembly Working Drawings at the site prior to and during installation of the deck joint assembly.

920.04.01.02.02 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 alphanumeric 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.

920.04.01.02.03 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.

920.04.01.03 Field Dimensions

Prior to the commencement of fabrication of the deck joint assembly, the Contractor shall submit to the Contract Administrator a drawing indicating the actual joint dimensions at the existing deck joint assembly locations.

920.04.01.04 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.

920.04.01.05 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, metric 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.

920.04.01.06 Interim Inspection After Fabrication of Expansion Joints

Upon completion of fabrication, the Quality Verification Engineer shall conduct an interim inspection of the work to verify that the fabrication of the expansion joint has been carried out according to the deck joint assembly Working Drawings and Contract Documents and issue written permission to proceed with the delivery.

920.05 MATERIALS

920.05.01 Antiseize Compound

Antiseize compound shall be according to OPSS 1210.

920.05.02 Bonding Agent

Bonding agent shall consist of Portland cement, Type GU, and sand in the ratio of 1:1 by volume and 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.

920.05.02.01 Sand

Sand for the bonding agent shall be mortar sand according to OPSS 1004.

920.05.03 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.
- 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.
- d) The requirements for air void system parameters of the hardened concrete, rapid chloride permeability, and compressive strength do not apply.

920.05.04 Deck Joint Assemblies

Deck joint assemblies shall be according to OPSS 1210.

920.05.05 Granular Materials

Granular A shall be according to OPSS 1010.

920.05.06 Joint Fillers

Joint fillers shall be according to OPSS 1308.

920.05.07 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.

920.05.08 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.

920.05.09 Preformed Seals

Preformed seals shall be according to OPSS 1210.

920.05.10 Water

Water used for curing and making bonding agent 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 deck joint assembly Working Drawings.

Any damage to the corrosion protection system, including surface areas of field welds, shall be repaired with 2 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 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 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 deck joint assembly Working Drawings. For new construction, where 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 centreline 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 blockout shall be formed for the deck joint assembly during concrete construction of the deck, ballast wall, and barrier or parapet wall. When new barrier or parapet walls are to be constructed, bulkheads shall be used to form blockouts in the barrier or parapet wall for the deck joint assemblies. The dimensions of the blockout in the barrier or parapet wall shall not be greater than those of the blockout in the deck and ballast wall except for the modular joints in structures. The removal of concrete required to prepare the blockout shall be carried out prior to the paving operation.

Prior to filling the blockout, the expansion joint gap shall be plugged to support the material placed in the blockout. The method used to plug the gap shall accommodate the anticipated movement of the structure and retain the blockout material until the joint is to be placed. Granular A shall be used to fill the blockout and then compacted to 100% of the maximum dry density according to OPSS 501. Granular A shall be placed as follows:

- a) When only construction vehicles and equipment are going to use the bridge and cross over the blockout prior to asphalt paving, the Granular A shall be placed from the top of the plug up to a height that is level with the top of the adjacent concrete.
- b) When traffic is to be maintained on the bridge and cross over the blockout prior to asphalt paving, the Granular A shall be capped with 50 mm of cold mix or hot mix asphalt placed level with the top of the adjacent concrete. The top surface of the asphalt shall be maintained smooth and level with adjacent concrete and shall not ravel.

Prior to asphalt paving, the edges of the blockout shall be accurately marked and the markings shall be visible after paving so that the joint location can be accurately identified. 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.

When bridge deck waterproofing and asphalt paving are part of this Contract, all material used to fill the blockout shall be removed within 5 Working Days of asphalt being placed, as follows:

- a) The new asphalt pavement shall be saw cut full depth at the limits of the blockout.
- b) The asphalt from the blockout areas shall be removed and temporary wood angles with a minimum thickness of 19 mm shall be placed to protect the saw cut asphalt edges for the full depth of asphalt.
- c) All the material used to fill the blockout and to plug the expansion gap, including any supports or bracing, shall be removed to the depth of the bearing seat.
- d) Asphalt residue shall be cleaned from the steel reinforcement.

Before placing the steel reinforcement, the concrete faces of the blockout shall be abrasive blast cleaned according to OPSS 929. After completion of this work, the deck joint assembly shall be placed in the blockout 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 blockout, the top setting devices shall be adjusted to give the specified setting width required by the 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 steel reinforcement. 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.

Concrete shall be placed in the blockout no later than 48 hours after the blockout surfaces have been abrasive blast cleaned or the blockout surfaces 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 wooden float. All steel surfaces that are going to be in contact with the preformed seal shall be protected during concrete placement.

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 2 to 4 hours after the concrete placement.

The setting device boltholes 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 saw cut a 20 mm wide groove for the full depth of asphalt adjacent to each steel nosing angle. If the previously saw cut 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 with an approved elastomeric concrete is specified in the Contract Documents, the mixing, placing, and curing requirements 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 ± 5 °C prior to its use.

920.07.01.05.02 Injection Method

Only the supplier of the expansion joint system or an agent approved by the supplier 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 2 m 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 where voids are detected and voids and boltholes 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.

Before installation of a new deck joint assembly and new steel reinforcement, the existing steel reinforcement, structural steel, and existing concrete against which new concrete is to be placed shall be abrasive blast cleaned according to OPSS 929.

Where a new joint assembly is to be welded to existing hardware, the surface of the existing hardware that is going 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 pre-dampened for 1 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.

When required, the Contract Administrator shall identify repairs to existing concrete within the blackout. Concrete removal and repairs shall be according to OPSS 928 and OPSS 930.

920.07.04 Field Installation of Preformed Seals and Bolted Components

Preformed seals shall be installed with lubricant in one continuous piece. Seals shall not be bent more than 30° at any one location.

Prior to installation of the preformed seal, all steel surfaces in contact with the preformed seal shall be cleaned and the gap completely clear for its full length and width to the depth of the bearing seat. The preformed seal and bolted components shall be installed according to the deck joint assembly Working Drawings. Adhesives and sealants shall not be used.

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 such 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 such 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 is going to be in contact with the sealing compound shall be 2 °C or greater at the time of installation.

920.07.07 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 this specification.

920.07.08 Corrective Work for Initial Acceptance

All defects or deficiencies 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.

920.07.09 Quality Control

920.07.09.01 Expansion Joint 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 before acceptance, the joint shall be water tested over its entire length where there are no upturns. Where there are upturns, the joint shall be tested between the gutter lines. The water shall be continuously ponded for a minimum of 1 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 is to 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 or at an elastomeric concrete-to-concrete interface or both 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. Where this is not feasible, a proposal detailing an alternative solution shall be submitted to the Contractor Administrator for approval.

920.07.09.02 Certificate of Conformance Upon Completion of the Work

Upon completion of installation of expansion joints, the Contractor shall submit, to the Contract Administrator, a Certificate of Conformance sealed and signed by a Quality Verification Engineer.

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 are free from deficiency for a period of two 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 two years for the Contractor to correct any defects or deficiencies, the warranty shall continue until repair or replacement has been completed to the satisfaction of the Owner.

920.07.10.02 Warranty Evaluation

Within 2 months of the expiry of the two-year Warranty Period, the Owner shall evaluate the deck joint assembly according to the requirements of the Criteria for Final Acceptance of Deck Joint Assemblies subsection. 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 or deficiencies that require corrective work based on the Criteria for Final Acceptance of Deck Joint Assemblies subsection.

Where 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 proposal for the method of 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 or deficiencies to the satisfaction of the Owner according to the requirements of this specification and the approved proposal. If the deck joint assembly has to be replaced, its successor shall be an equivalent approved joint.

All corrective work shall be done within 3 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 3 Business Days notice to the Owner prior to carrying out any corrective work.

920.07.11 Management of Excess Materials

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

For testing according to Table 1 in OPSS 1210, a sample shall be taken from the extra length of preformed seal supplied for each joint delivered to the Working Area.

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 defects or 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 deck joint assembly Working Drawing.
- f) Defective, loose, or missing structural components and welds.
- g) Leakage at interfaces determined according to the Quality Control-Water Test subsection.
- 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 defects or 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.

The deck joint assembly shall be rejected if any defect or deficiency listed above is not corrected to the satisfaction of the Owner.

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 in existing structures shall be administered as Extra Work.

920.10.03 Repairs of Defects and Deficiencies

Repair of defects or deficiencies identified during the inspection for initial acceptance of deck joint assemblies shall be completed at the Contractor's expense at no extra cost to the Owner.

Repair of defects or deficiencies required for final acceptance of the deck joint assembly prior to the end of the Warranty Period shall be completed at the Contractor's expense at no extra cost to the Owner.

920.10.04 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 2008
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 STRUCTURE REHABILITATION-CONCRETE REMOVAL

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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 provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

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 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.

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

Ontario Provincial Standard Specifications, Construction

OPSS 905 Steel Reinforcement for Concrete

CSA Standards

CAN/CSA S6-06 Canadian Highway Bridge Design Code

928.03 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.

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.

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

Layer - Reinforcing Steel means two or more reinforcing bars placed in a plane parallel to a concrete face.

Mat - Reinforcing Steel means two layers of reinforcing steel, in different directions, tied together.

Quality Verification Engineer (QVE) means an Engineer retained by the Contractor qualified to provide the services specified in the Contract Documents.

Rehabilitation means any modification, alteration, or improvement to a structure or its components that is designed to correct defects or deficiencies.

Reinforcing Steel means deformed steel bars used in the reinforcing of concrete and includes splice bars.

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.

Steel Reinforcement means a general term that includes reinforcing steel bars, splice bars, welded steel wire fabric, and prestressing tendons.

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 CAN/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.

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 check Engineer employed or retained by the Contractor, and a statement certifying that based on the existing drawings of the structure that the serviceability limit state and ultimate limit state requirements of CAN/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 Quality Verification Engineer (QVE) 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 amoil 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.

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 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.

The maximum time period required to complete the concrete surveys 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 ± 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 m², 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.

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 Certificate of Conformance

A Certificate of Conformance shall be submitted by the Contractor upon completion of the designated concrete removal for each structural component and complete deck. The certificate shall be sealed, signed, and dated by the Quality Verification Engineer. The certificate shall state that the Work has been carried out in general conformance with the Working Drawings and the Contract Documents.

928.07.10 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 m².

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 m².

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 m².
- b) A minimum of ten measurements for every square metre for each removal area greater than 1.0 m².

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 m³.

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 m³.

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 m²	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 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

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



**CONSTRUCTION SPECIFICATION FOR
STRUCTURE REHABILITATION - CONCRETE PATCHES,
REFACING, AND OVERLAYS**

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930-A	Commentary

930.01 SCOPE

This specification covers the requirements for concrete structure rehabilitation, including; concrete patches, concrete refacing, normal concrete overlays, and silica fume concrete overlays.

930.01.01 Specification Significance and Use

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

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 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.

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

Ontario Provincial Standard Specification, 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 Specification, Material

OPSS 1302	Water
OPSS 1350	Concrete - Materials and Production

Ontario Ministry of Transportation Publications

Structure Rehabilitation Manual

MTO Laboratory Testing Manual:

LS-430	Method of Test for Bond Strength by Tensile Load
LS-435	Method of Test for Linear Shrinkage of Concrete
LS-601	Materials Finer than 75 µm Sieve in Mineral Aggregates by Washing
LS-607	Determination of Percent Crushed Particles in Processed Coarse Aggregate

MTO Forms:

PH-CC-736	Notification of Placement of Concrete

CSA Standards

A23.2-14C	Obtaining and Testing Drilled Cores for Compressive Strength Testing*
C22.2 No. 211.2-M1984 (1992)	Rigid PVC (Un-plasticized) Conduit
G30.5-M1983 (R1998)	Welded Steel Wire Fabric for Concrete Reinforcement

* [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

A 53/A 53M	Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
A 123/A 123M	Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
A 153 - 09	Zinc Coating (Hot-Dip) on Iron and Steel Hardware
D 4285-83-(R2006)	Method for Indicating Oil or Water in Compressed Air

930.03

DEFINITIONS

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

Concrete Patches, Formed Surfaces means concrete patches where at least one face of the patch requires formwork.

Concrete Patches, Unformed Surfaces means concrete patches located in the top surface of decks, sidewalks, and curbs where no formwork is required.

Concrete Refacing means concrete refacing where at least one of the surfaces of a component is entirely overlaid with concrete. Concrete refacing typically applies to pier columns, pier caps, abutments, vertical walls of culverts and tunnels, concrete barrier, and parapet walls.

Form and Pump Placement Method means a method of placing concrete by pumping directly into formwork through injection ports.

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 temperature.

Injection Port means a mechanical device with a manual shut-off that is attached to the formwork and connected to the discharge line of a pump to facilitate delivery of concrete directly into the formwork.

Rehabilitation means any modification, alteration, or improvement to a structure or its components that is designed to correct defects or deficiencies.

Self-Consolidating Concrete (SCC) means a highly flowable yet stable concrete that can spread readily into place, fill the formwork, and encapsulate the reinforcement without any mechanical consolidation or vibration and without undergoing segregation or excessive bleeding. It may be designed for high strength and durability in addition to flow characteristics.

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.

Silica Fume Concrete means concrete which includes silica fume and may in addition include other supplementary cementing materials having specified rapid chloride permeability at 28 to 32 Days of 1,000 coulombs or less.

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.

930.04 DESIGN AND SUBMISSION REQUIREMENTS

930.04.01 Design Requirements

930.04.01.01 Formwork and Falsework

Design submission shall be according to OPSS 919 with the following additional requirements:

- a) Working Drawings for soffit repairs shall be designed and sealed by an Engineer.
- b) Formwork and falsework for soffit repairs subjected to live traffic vibrations on the deck shall be designed for an additional dynamic load allowance of 50% the weight of plastic concrete being supported.

Timber formwork and falsework for soffit repairs shall be designed using permanent load duration factors and shall accommodate additional pressure due to pumping of repair concrete.

930.04.02 Submission Requirements

930.04.02.01 Notification of Placement of Concrete

Prior to each placing operation, form PH-CC-736, accompanied by all supporting documentation as indicated on the form shall be submitted to the Contract Administrator.

930.04.02.02 Cold Weather Protection

930.04.02.02.01 General

A description of the methods to be used to control the concrete temperature and temperature difference in cold weather shall be submitted to the Contract Administrator 3 Days prior to the commencement of concrete production. Cold weather is considered to exist 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 temperature. The submission shall be according to the Temperature Control Plans clause of OPSS 904.

930.04.02.02.02 Temperature Records

Datalogger temperature records and a record of any actions taken to maintain control of temperature and temperature difference shall be submitted to the Contract Administrator at the end of each Business Day during the temperature monitoring period. At the end of the temperature monitoring period, a complete temperature record shall be submitted to the Contract Administrator.

930.04.02.03 Concrete Mix Design

Concrete mix design submissions shall be according to OPSS 1350, with the additional requirement that test data for linear shrinkage shall be required and submitted within 40 Days of the mix design submission.

930.04.02.04 Hot Weather Concreting

A description of the methods to be used to control the concrete temperature shall be submitted to the Contract Administrator 3 Days prior to the commencement of concrete production in hot weather.

930.04.02.05 Placement Methods

When the form and pump placement method is specified in the Contract Documents or self-consolidating concrete is used, 4 copies of the details of the placement method shall be submitted to the Contract Administrator at least 3 Days prior to commencement of the work. The details shall include methodology and equipment to be used and shall bear the seal and signature of an Engineer.

930.04.02.06 Formwork and Falsework

Working Drawings for soffit repairs shall be submitted to the Contract Administrator 3 Days prior to the commencement of formwork and falsework installation, for information purposes only.

930.05 MATERIALS

930.05.01 General

The following materials shall be according to OPSS 904:

- a) Burlap.
- b) Insulation material.
- c) Moisture vapour barrier.

If a bonding agent is used, it shall be compatible with the repair material.

930.05.02 Anchors

Anchors for the attachment of the welded steel wire fabric to the concrete surface shall be galvanized according to ASTM A 153 and be of adequate length and strength to resist a pull-out force of 1.0 kN.

930.05.03 Concrete

The concrete shall be according to OPSS 1350 with the following modifications:

- a) The minimum specified 28-Day compressive strength shall be 30 MPa, except for silica fume overlays which shall be 40 MPa.
- b) Coarse aggregates for overlays shall consist of a minimum of 60% crushed particles when tested according to MTO LS-607 and shall have 1.00% by mass maximum passing the 75 µm sieve when tested according to MTO LS-601. Coarse aggregate for overlays that form the bridge deck riding surface shall be composed of at least 80% siliceous rocks and minerals.
- c) Linear shrinkage test data for each mix design shall be submitted for information purposes. Testing shall be carried out in accordance with LS 435 and specimens may be cast at the ready mixed plant or at the site. Laboratory testing shall be carried out by a laboratory who has participated in an MTO correlation program for linear shrinkage.

- d) For concrete patches where the longest dimension, width or length, of individual patches is less than 400 mm, a proposal may be submitted to the Contract Administrator for approval to use a proprietary patching material. The patching material shall be mixed, handled, and cured according to the manufacturer's instructions.
- e) SCC will be considered on an individual project basis for patches and refacing subject to the Contract Administrator's approval. If permitted for use, SCC shall be according to the ministry's current specification for SCC. A copy of the specification can be obtained from the Ministry's Material Engineering and Research Office, 1201 Wilson Avenue, Downsview, M3M 1J8.

930.05.04 Drainage Tubes

Rigid polyvinyl chloride (PVC) drainage tubes shall be according to CSA C22.2 No. 211.2. Galvanized steel drainage tubes shall be according to ASTM A53/A53M and galvanizing shall be according to ASTM A 123.

930.05.05 Forms

Forms shall be according to OPSS 919, with the exception that all forms shall be medium density overlay plywood.

930.05.06 Proprietary Patching Materials

Proprietary patching materials shall be from the ministry's list of concrete patching materials.

930.05.07 Tie Wire

Tie wire shall be according to OPSS 905.

930.05.08 Welded Steel Wire Fabric

Welded steel wire fabric shall be welded galvanized steel and shall be according to CSA G30.5. Galvanizing shall be according to ASTM A 123.

930.05.09 Water

Water used for curing, fog-misting of concrete, pre-soaking of burlap, and bonding agent shall be according to OPSS 1302.

930.06 EQUIPMENT

930.06.01 General

The following equipment shall be according to OPSS 904:

- a) Bridge deck finishing machine, screed rails, screed rail chairs, and work bridges used for overlays.
- b) Consolidating equipment.
- c) Hand finishing tools.
- d) Straight edges.

930.06.02 Buggies

Buggies used for transporting and placing the concrete may be hand operated or motorized. Motorized concrete buggies shall have a capacity no greater than 0.5 m³.

930.06.03 Compressor - Air Blasting

The compressed air shall be clean, dry, and free from oil residue and other contaminants when tested according to ASTM D 4285.

930.06.04 Fog Misting Equipment

Fog misting equipment shall be provided for the curing of the silica fume concrete overlays. Hand held fogging wands shall be used.

A fogging system mounted on the finishing machine may also be used, provided it does not result in dripping or accumulation of water on the concrete surface.

930.06.05 Form and Pump Placement Method Equipment

When the form and pump placement method is specified in the Contract Documents, the pump shall be a positive displacement type pump and shall be capable of delivering adequate volumes of concrete to maintain a continuous placement.

930.06.06 Sawing Equipment - Overlays

The sawing equipment shall be self-propelled and capable of sawing the concrete overlay full depth in one pass.

930.07 CONSTRUCTION

930.07.01 General

Typical locations and areas of repair are as shown on the Contract Drawings; 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.

930.07.02 Operational Constraints

The Contract Administrator shall be notified of the intent to place the overlay, concrete patches, or concrete refacing 1 Business Day prior to the commencement of the placing operation. The work shall not proceed until the concrete surface preparation has been completed and form PH-CC-736 has been received and signed by the Contract Administrator.

Construction equipment shall be permitted on the bridge deck or other concrete components, provided that:

- a) Contamination by oil or other deleterious substances is prevented.
- b) Equipment vehicles and runways are not supported by steel reinforcement.
- c) Only the finishing machine and buggies used to place concrete are allowed on the abrasive blast cleaned portions of the deck or other concrete components. No other vehicles or equipment, including concrete ready mix trucks shall be permitted.

- d) Heavy vehicles such as concrete ready mix 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.

No construction vehicles, equipment, or traffic, with the exception of sawcutting equipment shall be permitted on the finished surface of the overlay, patches, and on deck surface directly over soffit patches or refacing until the curing and cold weather protection period has been completed and a minimum compressive strength of 25 MPa has been attained.

Prior to seasonal shutdown, operations shall be scheduled in such a manner to ensure that overlays, concrete patches, and concrete refacing are completed in all areas where concrete removal has commenced. No steel reinforcement shall be left exposed during seasonal shutdown.

**930.07.03 Normal Concrete Overlay
 Silica Fume Concrete Overlay**

930.07.03.01 Minimum Thickness of Overlay

The thickness of the overlay shall be according to the requirements of the Contract Drawings with no areas less than 45 mm in thickness.

930.07.03.02 Surface Preparation

All concrete surfaces against which new concrete is to be placed shall be clean, sound 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.

A bonding agent may be used. The Contract Administrator shall be notified in writing whether a bonding agent is to be used and, if so, the bonding agent shall be identified.

The portion of curb face, barrier wall or parapet wall, and all existing concrete surfaces which have not been scarified, against which new concrete is to be placed, 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 and steel reinforcement to receive the overlay shall be abrasive blast cleaned according to OPSS 929.

Immediately prior to pre-wetting the concrete surface, all dust and loose material shall be removed from the prepared surface by using compressed air, except where anode mesh is to be used.

When anode mesh is required, the concrete surface shall be pressure washed with water using a pressure not less than 10 MPa with the anode mesh in place. The pressure washing shall take place immediately prior to pre-wetting. All debris resulting from drilling of anchor holes and other accumulated dirt adhering to the anode or concrete surfaces shall be removed.

All concrete surfaces to receive an overlay shall be pre-wetted and continuously maintained in a wet condition for a minimum period of 6 hours immediately prior to the application of the concrete overlay or bonding agent when used. Excess water shall be removed from the surface using compressed air immediately prior to the application of the bonding agent or concrete overlay.

930.07.03.03 Placing of Screed Rails

Supports for the screed rails shall be installed outside the area to be overlaid or waterproofed. 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.

930.07.03.04**Dry Run**

A dry run shall be made to verify that the minimum thickness of the overlay can be achieved, in the presence of the Contract Administrator, prior to each placing operation.

The Contract Administrator shall be notified at least 1 Business Day in advance of a dry run. When the dry run indicates that an unsatisfactory thickness will result, the screed rails shall be adjusted in order to obtain the minimum thickness and the dry run repeated in the area of screed rail adjustment.

For silica fume concrete overlays, the ability to successfully fog mist shall be demonstrated to the Contract Administrator at the time of the dry run. The same equipment and process shall be used to fog mist the overlay.

930.07.03.05**Placing of Concrete**

The placing of concrete shall be according to OPSS 904 with the following modifications:

- a) Concrete shall not be placed when the ambient air temperature 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 throughout the duration of the concrete placing operation.

Prior to placing new concrete, it shall be demonstrated to the Contract Administrator that the substrate temperatures meet the Contract requirements, by measuring and recording the substrate temperatures using a contact thermometer or infrared thermometer.

- b) Concrete shall not be placed adjacent to any new concrete less than 48 hours old. If the ambient air temperature falls below 10 °C within the first 48 hours after placement of concrete, the 48 hour time requirement shall be extended to 96 hours.

In addition, for staged overlay construction, concrete shall not be placed adjacent to any new concrete having a compressive strength less than 20 MPa.

- c) All concrete overlay 3 m or wider shall be placed with bridge deck finishing equipment.
- d) Any concrete or bonding agent deposited in areas other than the intended point of discharge shall be removed immediately.
- e) Unless otherwise specified in the Contract Documents, concrete for partial depth removal areas shall be placed at the same time as the overlay. Concrete for full depth removal areas shall be placed prior to placing the overlay and left with a rough surface finish.
- f) Cold joints shall not be permitted.

930.07.03.06**Construction Joints**

Construction joints shall be permitted only where shown in the Contract Drawings or in the case of unexpected interruptions during the placing operation, as directed by the Contract Administrator.

All construction joints shall be formed using bulkheads. The height of the bulkhead shall match the thickness of the overlay.

The edge and face created by the bulkhead shall be a clean vertical face free from any defects such as honeycombing or spalls. If the construction joint formed by the bulkhead is deemed unacceptable by the Contract Administrator, a new construction joint shall be created by sawcutting back to a limit where the quality of concrete is acceptable to the Contract Administrator.

930.07.03.07 Surface Finish

The surface finish shall be according to OPSS 904.

930.07.03.08 Surface Tolerance

The surface tolerance shall be according to OPSS 904.

930.07.03.09 Surface Texture

Where the surface of the overlay forms the driving surface of the bridge deck, 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 which 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 300 mm of the curb or barrier wall or parapet wall.

930.07.03.10 Curing

Normal concrete overlay shall be cured according to the requirements for Curing with Burlap and Water clause of OPSS 904 for a minimum curing period of 4 Days, except that for concrete subjected anytime to cold weather during the first 96 hours after concrete placement, the curing period shall be extended to 7 Days.

Silica fume concrete overlay shall be cured according to the requirements for high performance concrete (HPC) of OPSS 904 for a minimum curing period of 7 Days.

Where waterproofing is to be applied to an overlay following curing with burlap and water, the overlay shall be air dried for at least 72 hours prior to the application of waterproofing.

930.07.04 Concrete Patches, Formed Surface Concrete Patches, Unformed Surface Concrete Patches, Form and Pump Concrete Refacing Concrete Refacing, Form and Pump

930.07.04.01 Surface Preparation

All concrete surfaces against which new concrete is to be placed shall be clean, sound 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.

A bonding agent may be used. The Contract Administrator shall be notified in writing whether a bonding agent is to be used and, if so, the bonding agent shall be identified.

All existing concrete surfaces against which new concrete is to be placed 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 and steel reinforcement to receive new concrete shall be abrasive blast cleaned according to OPSS 929.

Immediately prior to pre-wetting the concrete surface, all dust and loose material shall be removed from the prepared surface of the repair area by using compressed air.

The surface of the existing concrete shall be pre-wetted and continuously maintained in a wet condition for a period of 6 hours immediately prior to placing any new concrete. Prior to placing concrete, excess water shall be removed from the surface using compressed air.

930.07.04.02**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 welded steel wire fabric shall not be abrasive blast cleaned at any time.

Where there is no exposed steel reinforcement, the wire fabric shall be fastened to the concrete with anchors placed no further than 600 mm apart, in a grid pattern.

Where steel reinforcement is exposed, the wire fabric shall be securely fastened to the steel reinforcement by tie wires placed no further than 600 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.

The wire fabric shall be installed flat, tight, and at the locations shown in the Contract Drawings using spacers and anchors. The edges of adjoining wire fabric shall overlap by two-wire spacing plus 100 mm. The wire fabric shall be kept clean of any contamination that could reduce the bond of the repair material to the wire surface.

930.07.04.03**Installation of Anchors and Dowels**

Holes for anchors and dowels shall be drilled into the concrete at the location and spacing as specified in the Contract Documents. They shall be installed in such a way as to not cause delamination or other damage to the surrounding concrete. Each anchor used to fasten the welded steel wire fabric into the concrete shall be installed to resist a pull out force of at least 1.0 kN at either sides of the concrete interface.

930.07.04.04**Formwork and Falsework**

The erection and removal of formwork and falsework shall be according to OPSS 919 and it shall be designed to retain the concrete and withstand the placement pressures. The formwork shall be placed to provide the specified cover to steel reinforcement or welded steel wire fabric, 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 edges of the repair area. The perimeter of the formwork shall be sealed to be grout-tight. Vent holes shall be installed at the highest locations.

930.07.04.05**Placing of Concrete**

The placing of concrete shall be according to OPSS 904 with the following modifications:

- a) Concrete shall not be placed when the ambient air temperature 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 throughout the duration of the concrete placing operation.

Prior to placing new concrete, it shall be demonstrated to the Contract Administrator that the substrate temperatures meet the Contract requirements by measuring and recording the substrate temperatures using a contact thermometer or infrared thermometer.

- b) Concrete shall not be placed adjacent to any new concrete less than 48 hours old. If the ambient air temperature falls below 10 °C within the first 48 hours after placement of concrete, the 48 hour time requirement shall be extended to 96 hours.
- c) For form and pump method, the port arrangement and pumping procedures shall be designed to ensure that requirements of this specification are met.
- d) Cold joints shall not be permitted.

930.07.04.06 Construction Joints

Construction joints in concrete shall be permitted at the locations shown on the Contract Drawings and shall be according to OPSS 904. Any additional construction joints required to suit the construction operation and to meet the specified crack control criteria shall be subject to approval by the Contract Administrator.

930.07.04.07 Surface Finish

The surface finish shall be according to OPSS 904.

930.07.04.08 Surface Tolerance

The surface tolerance shall be according to OPSS 904.

930.07.04.09 Curing

930.07.04.09.01 General

Normal concrete shall be cured for a minimum period of 4 Days, except that for concrete subjected anytime to cold weather during the first 96 hours after concrete placement the curing period shall be extended to 7 Days.

930.07.04.09.02 Unformed Surfaces

Concrete shall be cured for the full duration of the curing period according to the Curing with Burlap and Water clause in OPSS 904. The burlap and the moisture vapour barrier shall then be removed and the concrete permitted to air dry for not less than 72 hours prior to any application of tack coat for waterproofing, where applicable.

930.07.04.09.03 Formed Surfaces

930.07.04.09.03.01 General

All exposed concrete surfaces of formed components shall be cured as specified in the Unformed Surfaces clause.

930.07.04.09.03.02 Concrete Patches, Formed Surface Concrete Patches, Form and Pump

Curing shall be according to the following:

- a) If the formwork is left in place for the duration of the curing period, no additional curing shall be required.
- b) Where the formwork is to be removed within the specified curing period, curing shall be applied as specified in the Unformed Surfaces clause, curing shall be applied immediately after removal of the formwork and remain in place until the end of the curing period. Under no circumstance shall the concrete be left uncured for more than 2 hours during the removal of formwork.

930.07.04.09.03.03 Concrete Refacing Concrete Refacing, Form and Pump

Burlap and water shall be applied immediately to the top of all exposed concrete surfaces, within 2 to 4 m of the finishing operation. The burlap shall be soaked for 24 hours prior to placing and shall be kept continuously wet by means of an operating soaker hose placed along the top of the component being refaced. The soaker hose shall be placed immediately after the concrete has set and its operation shall not cause fines to be washed out.

Forms for all surfaces, except soffit for structural components, shall be removed within 16 to 24 hours of concrete placement, unless the Contractor is unable to remove the forms due to structural concerns. All concrete surfaces shall be immediately covered with wet burlap and moisture vapour barrier for the remainder of the minimum curing period according to the requirements of Curing with Burlap and Water clause in OPSS 904. Under no circumstance shall the concrete be left uncured for more than 2 hours during the removal of the formwork.

Forms for soffit of structural components including decks, pier caps, beams, and arch ribs shall not be removed until the full curing time has elapsed.

930.07.05 Cold Weather Protection

930.07.05.01 General

Concrete shall be protected 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.

Regardless of ambient air temperature, overlays shall be moist cured with burlap and water at all times. During cold weather, burlap shall be prevented from freezing.

930.07.05.02 Control of Temperature and Temperature Difference

During cold weather, the temperature of the concrete shall be monitored and controlled according to the Control of Temperature and Temperature Difference subsection in OPSS 904, with the following exceptions:

- a) Thermocouple wires shall be embedded near the concrete surface in a minimum of 4 locations for each Day of concrete placement, as directed by the Contract Administrator. Thermocouples for monitoring ambient air temperature shall be installed in the shade close to the surface of the concrete at a minimum frequency of 1 thermocouple for each Day of placement.
- b) For cold weather conditions, protection of concrete shall, at a minimum, be as shown in Table 1. Protective measures shall be increased based on consideration of the specific type of rehabilitation in order to comply with the specified temperature constraints, as required.
- c) The cold weather protection shall be gradually removed or reduced in such a manner that the maximum allowable drop of concrete temperature for each 24 hour period as shown in Table 1 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 air temperature.

930.07.06 Material Sampling and Testing

930.07.06.01 Plastic Concrete Testing

The sampling and testing of the plastic concrete for slump, air content, and temperature shall be according to OPSS 1350 with the exception that the minimum frequency of testing shall be one test from each load of concrete. Results shall be recorded and shall be submitted to the Contract Administrator, upon request.

930.07.06.02 Early Strength Determination

Where early loading of concrete is proposed or anticipated, sets of cylinders for testing for early strength determination shall be prepared according to OPSS 904.

930.07.06.03 Samples for Compressive Strength, Air Void System Parameters and Rapid Chloride Permeability - Acceptance Testing

The Contractor shall be responsible for sampling and transportation of samples for acceptance testing of compressive strength, air void system, and rapid chloride permeability by the Owner according to OPSS 1350.

930.07.06.03.01 Samples for Acceptance Testing Where Rehabilitation Involves the Use of Anode Mesh Cathodic Protection

Cylinders for acceptance testing of compressive strength shall be according to OPSS 1350.

Where anode mesh is used, cores shall not be required and cylinders shall be cast for determination of air void system and rapid chloride permeability. One cylinder shall be made for determination of air void system parameters to represent each 300 m² of surface area of overlay and for each 100 m² of surface area of patches and refacing placed.

For silica fume overlays, two additional cylinders shall be made for determination of rapid chloride permeability to represent each 300 m² of surface area of overlay placed. One cylinder shall be used for acceptance testing and the remaining cylinder shall be retained for referee testing.

The cylinders shall be 100 mm diameter x 200 mm long and shall be made, field cured, and transported according to the Test Cylinders clause in OPSS 1350.

930.07.06.04 Tensile Bond Strength

The following shall be marked to facilitate the selection of testing locations and avoid damage to the embedded materials due to coring:

- a) For rehabilitation involving use of anode mesh cathodic protection in overlay, the locations of anode distribution bars, wiring, and embedded hardware.
- b) For rehabilitation involving use of glass fiber reinforced polymer (GFRP) reinforcing, the reinforcing bar locations.

Application of tack coat, where applicable, shall not be carried out until the testing of tensile bond strength is completed.

930.07.06.05 Filling of Core Holes

Filling of core holes shall be according to OPSS 1350.

930.07.07 Remedial Work

Remedial work shall be carried out as shown in Table 2.

Treatment for deck with waterproofing and paving shall not begin until the specified curing period and the air drying period has elapsed. For all other exposed components, the treatment shall not begin until a minimum period of 28 Days has elapsed after placement of concrete.

Repair of cracks shall be according to OPSS 932. Alternatively, a proposal for repair may be submitted to the Contract Administrator for review to show that the repair method and material shall be able to restore the structural integrity of the concrete across the cracks. The inspection and monitoring of cracks shall continue up to the date of waterproofing or completion of the Work, whichever is later.

The application of tack coat for waterproofing shall not proceed until all defects have been addressed and remedial work accepted by the Contract Administrator.

930.07.08 Modification of Deck Drains

Modification of deck drains shall be made prior to waterproofing the deck.

930.07.09 Drainage Tubes in Deck

Installation of drainage tubes shall be made prior to waterproofing the deck.

930.07.10 Management of Excess Materials

Management of excess material shall be according to the Contract Documents.

930.08 QUALITY ASSURANCE

930.08.01 Testing - Tensile Bond Strength

The Contract Administrator shall use a covermeter to locate steel reinforcement prior to testing in order to avoid coring through the steel and shall perform the sampling and testing of cores from overlays, concrete patches, and concrete refacing to determine tensile bond strength.

A lot shall consist of the total quantity of concrete patches, concrete refacing, or overlay for each item, except for the following where tensile bond shall not be measured:

- a) When the total measured area of concrete patches on a structure is less than 20 m².
- b) When the total area of concrete refacing on a structure is less than 20 m².
- c) In circular columns with spiral reinforcement.

Each lot shall be divided into sublots as follows:

- a) Sublots for overlays shall be approximately equal in size and not greater than 300 m². Separate sublots are required for each overlay placement.
- b) Sublots for concrete patches shall not be combined with areas of concrete refacing for determining sublots. Sublots shall be approximately equal in size and not greater than 100 m². Work on different structures shall not be combined in the same subplot.
- c) Soffit repairs shall be a separate subplot and a subplot shall not be greater than 100 m².

The tensile bond strength testing shall be carried out on 3 in-situ cores taken within 1 m of each other for each subplot. The core locations shall be randomly selected by the Contract Administrator. Additional testing shall not be permitted.

The cores shall be obtained by the Contract Administrator according to CSA A23.2-14C. Cores shall be 100 mm in diameter and extend into the parent concrete to the depth as specified in LS-430. The testing shall be according to LS-430 and shall be carried out when the concrete is 7 to 10 Days of age. The equipment used to measure the tensile bond strength shall be equipped with a maximum load indicator.

If a core comes loose during coring operation, another core shall be obtained within 300 mm of the original core location.

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. If a failure occurs fully within the parent concrete, this shall be considered a valid result, unless the Contractor has been directed to leave unsound concrete in place. Retesting is not required when the specified strength of 1.0 MPa has been achieved

Individual test results shall be forwarded to the Contractor, as they become available.

930.08.02 Inspection After Curing

The Contract Administrator shall inspect the Work to determine if the completed work contains any of the following defects:

- a) Areas of debonding.
- b) Honeycombed areas, spalls, and cold joints.
- c) Cracks requiring remedial work as shown in Table 2.

930.08.03 Acceptance

930.08.03.01 Concrete Compressive Strength, Air Void System in Hardened Concrete or Rapid Chloride Permeability for Silica Fume Overlays

Acceptance, referee testing and referee testing cost of concrete compressive strength, air void system in hardened concrete, and rapid chloride permeability for silica fume overlays shall be according to OPSS 1350.

930.08.03.02 Tensile Bond Strength

For a subplot to be acceptable, the average tensile bond strength of the subplot shall be a minimum of 1.0 MPa. Sublots with average tensile bond strength less than 1.0 MPa and more than or equal to 0.8 MPa shall be accepted with payment reduction. The payment reduction factor (Pr_i) for the tensile bond strength testing for each subplot shall be calculated based on the following equation:

$$Pr_i = 1.25 (1 - B)$$

Where:

B = The average tensile bond strength (MPa) for each subplot. For the purpose of calculating the payment reduction factor, a value of 1.0 MPa shall be used for B when the average tensile bond strength is greater than 1.0 MPa.

i = Sublot number

The payment reduction, Pr , for the lot is calculated by one of the following equations:

For the concrete patches, concrete refacing, place concrete overlay, and place silica fume concrete overlay items, the following equation shall be used:

$$Pr = \text{Tender Unit Price} \times [(Pr_1 \times LQ_1) + (Pr_2 \times LQ_2) \dots (Pr_n \times LQ_n)]$$

Where:

Pr_i = The payment reduction for subplot i

LQ_i = Quantity for subplot i (m^3)

n = The total number of sublots

For the finish and cure concrete overlay and finish and cure silica fume concrete overlay items, the following equation shall be used:

$$Pr = \frac{\text{Lump Sum} \times [(Pr_1 \times SA_1) + (Pr_2 \times SA_2) \dots (Pr_n \times SA_n)]}{SA_T}$$

Where:

- Pri = The payment reduction for subplot i
- SA_i = Surface area for subplot i (m²)
- SA_T = Total surface area of the lot (m²)
- n = The total number of sublots

For the purpose of calculating the payment reduction for concrete overlays, the Pr shall be applied to both place concrete overlay and finish and cure concrete overlay items.

For the purpose of calculating the payment reduction for silica fume concrete overlays, the Pr shall be applied to both place silica fume concrete overlay and finish and cure silica fume concrete overlays items.

930.08.03.03 Acceptance at the Completion of Work

The Contract Administrator shall reject all or a portion of the subplot based on:

- a) The presence of debonding, honeycombed areas, spalls and cold joints.
- b) Cracks as shown in Table 2.
- c) Average tensile bond strength less than 0.8 MPa.
- d) Any work that does not meet the requirements of this specification and the acceptance requirements of OPSS 1350.
- e) Unsatisfactory completion of remedial work associated with surface tolerance, surface finish, cracks, or any other deficiencies.

930.08.03.04 Performance During General Warranty Period

In addition to the acceptance requirements stated herein, concrete in the structure shall meet the requirements as shown in Table 2 during and up to the end of the general warranty period.

930.09 MEASUREMENT FOR PAYMENT

930.09.01 General

For all types of overlays, there shall be no measurement for the following:

- a) Concrete produced in excess of that required for the placing operation.
- b) Quantity of bonding agent.

For construction joints in overlay that do not meet the requirements specified in this specification and is deemed unacceptable by the Contract Administrator, the portion of overlay removed shall be deducted from the volume indicated on the delivery ticket.

No measurement shall be made for areas of new overlays, concrete patches, and concrete refacing that were removed according to the requirements of the Remedial Work subsection.

930.09.02 Actual Measurement

**930.09.02.01 Place Concrete Overlay
Place Silica Fume Concrete Overlay**

Measurement shall be by the volume of concrete placed, including concrete placed in partial depth removals, in cubic metres by delivery ticket. Deductions shall be made for the following:

- a) Concrete produced in excess of that required for the placing operation.
- b) The portion of the overlay that is sawcut back and removed at the construction joint.
- c) The portion of concrete removals not approved by the Contract Administrator.

The total volume shall be calculated to the nearest cubic metre.

**930.09.02.02 Concrete Patches, Formed Surface
Concrete Patches, Unformed Surface
Concrete Patches, Form and Pump
Concrete Refacing
Concrete Refacing, Form and Pump**

930.09.02.02.01 By Volume

Measurement shall be by the volume of concrete placed in cubic metres.

The volumes shall be calculated by multiplying each area to be patched by the average depth. Depths shall be taken on a grid system to best describe the profile at the particular area. The Contract Administrator, in the presence of the Contractor, shall take a minimum of 3 measurements for each removal area or 10 for every m², after concrete removal is completed by placing a straight edge across the removal area and measuring the depth from the straight edge to the concrete.

The depths shall be measured and averaged to the nearest millimetre.

No measurement shall be made for concrete required to fill localized areas behind the second layer of steel reinforcement.

The total volume shall be calculated to the nearest 0.1 m³.

930.09.02.03 Modification of Deck Drains

For measurement purposes, a count shall be made of the number of deck drains modified.

930.09.02.04 Drainage Tubes in Deck

For measurement purposes, a count shall be made of the number of drainage tubes placed.

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 Silica Fume Concrete Overlay - Item
Finish and Cure Concrete Overlay - Item
Finish and Cure Silica Fume Concrete Overlay - Item
Concrete Patches, Formed Surface - Item
Concrete Patches, Unformed Surface - Item
Concrete Patches, Form and Pump - Item
Concrete Refacing - Item
Concrete Refacing, Form and Pump - 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, subject to payment adjustments as specified in the Contract Documents. Payment at the Contract price for the above tender items shall also include abrasive blast cleaning of the concrete surface for concrete patches and concrete refacing. Payment for abrasive blast cleaning of steel reinforcement and the concrete surface to receive an overlay shall be administered 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 concrete patching and concrete refacing items shall include full compensation for all labour, Equipment, and Material to do the work, including provision of access.

No payment shall be made for normal concrete, silica fume concrete or self-consolidating concrete or both required to patch, reface, or overlay areas of concrete removal where the removal was not approved by the Contract Administrator.

TABLE 1
Minimum Cold Weather Protective Measures

Anticipated Minimum Air Temperature °C	Protective Measure
+10 to +6	PM2
+5 to 0	PM3
-1 to -5	PM4
-6 and lower	PM5
Maximum Allowable Drop in Concrete Temperature / 24 hours	15 °C
PM2 - Protective Measure - Cover concrete with insulation having an R-Value of 0.67 ** PM3 - Protective Measure - Cover concrete with insulation having an R-Value of 1.33 ** PM4 - Protective Measure - Cover concrete with insulation having an R-Value of 2.00 ** PM5 - Protective Measure - House and heat according to the Housing and Heating clause of OPSS 904. ** Note: All R-Values are metric. The conversion factor from metric to imperial unit is: Metric R value x 5.678 = Imperial R value	

Table 2
Performance Requirements at Time of Construction and During Warranty Period

	Test Method	Performance Requirements	Consequence of Non-Conformance
Concrete Surface Scaling	Visual inspection and assessment of severity of-scaling according to Figures 1 to 6.	At the end of the warranty period, there shall be no medium or severe scaling and total area of light scaling shall be no more than 5% of the component.	Areas of medium and severe scaling shall be removed and replaced full depth. For light scaling greater than 5% of the component, the Contractor shall submit a repair proposal for approval by the ministry.
Concrete Delamination or Debonding	As described in the Structure Rehabilitation Manual.	Delaminated or debonded areas shall not be present.	Remove and replace.
Cracks	Visual inspection and measurement by means of crack comparator. Width of crack is measured at the widest point of the crack, not average width of crack. Cracks in overlays and patches to be waterproofed shall be measured after the air drying period.	For overlays and patches to be waterproofed and paved, width of cracks shall be less than 0.50 mm and linear measurement of cracks greater than 0.50 mm within 1 m ² shall be less than 2 m.	Repair cracks greater than 0.50 mm in width according to OPSS 932, unless the linear measurement of cracks greater than or equal to 0.50 mm per m ² exceeds 2 m. If the linear measurement of cracks greater than 0.50 mm in width exceeds 2 m per m ² , remove and replace.
		For exposed overlays, refacing and patches, width of cracks shall be less than 0.30 mm and linear measurement of cracks greater than 0.30 mm within 1 m ² shall be less than 2 m.	Repair cracks greater than 0.30 mm in width according to OPSS 932, unless the linear measurement of cracks greater than or equal to 0.30 mm per m ² exceeds 2 m. If the linear measurement of cracks greater than 0.30 mm in width exceeds 2 m per m ² , remove and replace.
Spalls, Exposed Reinforcement, Honey-Combing, and Other Observed Unanticipated Defects and Deterioration	Visual inspection.	Spalls, exposed reinforcement, honey-combing, or other observed defects and deterioration shall not be present at the end of the warranty period.	Remove and replace.
Note: A. Where the area failing to meet the performance requirement is a large proportion of the repair area, the entire repair shall be removed and replaced.			

FIGURE 1
Example of Light Scaling



FIGURE 2
Example of Light Scaling



FIGURE 3
Example of Medium Scaling



FIGURE 4
Example of Medium Scaling



FIGURE 5
Example of Severe Scaling



FIGURE 6
Example of Severe Scaling



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

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR IMPRESSED CURRENT CATHODIC PROTECTION SYSTEM FOR BRIDGE STRUCTURES

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APPENDICES

935-A	Commentary

935.01	SCOPE

This specification covers the requirements for the installation of cathodic protection system using anode mesh.

935.01.01 Specification Significance and Use

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

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

935.01.02 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.

935.02 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.

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
OPSS 904	Concrete Structures
OPSS 913	Embedded Work in Structures for Electrical Systems
OPSS 928	Structure Rehabilitation - Concrete Removal
OPSS 929	Abrasive Blast Cleaning - Concrete Construction
OPSS 930	Structure Rehabilitation - Concrete Patches and Overlays

Ontario Provincial Standard Specifications, Material

OPSS 1302	Water
OPSS 2301	Impressed Current Cathodic Protection System for Bridge Structures

Ontario Ministry of Transportation Publications

Designated Sources for Materials (DSM)

ASTM International

B 265-95	Titanium and Titanium Alloy Strip, Sheet and Plate
D 4285-83 (1993)	Test Method for Indicating Oil or Water in Compressed Air

Others

Ontario Traffic Signal Control Equipment Specifications (OTSCES)
NACE - National Association of Corrosion Engineers
Ontario Electrical Safety Code

935.03 DEFINITIONS

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

Cathode Connection means a cable connection of the following two types made to reinforcing bars:

- a) CS: a current carrying cathode connection that is connected to the negative terminal of the rectifier.
- b) CM: a non-current carrying cathode connection that is used to monitor the potential of the reinforcing steel with respect to a reference cell.

Corrosion Specialist means an individual having all of the following qualifications:

- a) A minimum of 5 years experience in cathodic protection of reinforced concrete structures.
- b) Is a NACE accredited cathodic protection specialist.
- c) Is an Engineer.

Distribution Bar means a component of the anode that distributes current from the power feed point.

Instant-Off means the potential reading taken immediately after the current flowing to the system has been interrupted.

Subzone means the division of a concrete component into areas where the anode in an area is not continuous with the anode in the adjacent area.

Zone means an area of a concrete component energized by one rectifier unit consisting of one or more subzones.

935.04 DESIGN AND SUBMISSION REQUIREMENTS

935.04.01 Submission Requirements

935.04.01.01 Working Drawings

At least 8 weeks prior to commencement of production of the cathodic protection assembly, 4 copies of the Working Drawings for the components listed below shall be submitted to the Contract Administrator, for information purposes only. Prior to submission, an Engineer's seal and signature shall be affixed on the Working Drawings verifying that the drawings are consistent with the requirements of the Contract Documents.

- a) The cathodic protection equipment assembly.

- b) The cathodic protection terminal block assembly.
- c) The cathodic protection remote monitoring and control unit.
- d) The cathodic protection rectifier.
- e) The wireless modem antenna.

The Working Drawings shall include the information specified in OPSS 2301.

The Working Drawings shall contain at least the following information:

- a) Dimensioned layout drawings including sections, block diagrams, and details to show enclosure, equipment layout, and mounting arrangement.
- b) Wiring diagram, including field location and function labels.
- c) Detailed bill of materials including sources.

935.04.01.02 Technical Documentation

Four copies of the following documents for each rectifier and for the RMU containing at least the following information shall be submitted to the Contract Administrator:

- a) Operation and maintenance manual.
- b) Complete schematic diagrams and parts lists.
- c) Drawings showing external and internal physical dimensions of the unit.
- d) Manufacturer's data sheets and engineering technical data for all electronic, electrical components, and mechanical parts of the unit.
- e) Detailed information and test procedures for trouble-shooting.
- f) Performance reports including the 180 hour burn-in test for the rectifier and RMU documenting all of the required tests for the rectifier and for the RMU.

Two copies of the RMU software shall be submitted to the Owner.

935.04.01.03 Notification of Production

The Contract Administrator shall be given at least one week prior notice of the date of commencement of fabrication and the date of completion of fabrication of the following components:

- a) The cathodic protection rectifier.
- b) The cathodic protection remote monitoring and control unit.

935.04.01.04 Notification of Suppliers

The names of the suppliers of the cathodic protection control and monitoring equipment shall be submitted to the Contract Administrator, upon request.

935.04.01.05 Spacer Grid

The product data sheet of the glass fibre reinforced polymer bars (GFRP) spacer grid shall be submitted to the Contract Administrator prior to installation.

935.04.01.06 Anode Mesh and Distribution Bars

At least one week prior to the commencement of the installation of the distribution bars and the anode mesh, the following samples fabricated with the equipment and procedures to be used in the work together with the power setting used in welding the samples shall be submitted to the Contract Administrator:

- a) Two 300 mm lengths of distribution bar overlapped and welded at 4 locations at 12 mm intervals.
- b) Anode mesh welded at the diamond junctions to two 500 mm lengths of distribution bars.

935.04.01.07 Corrosion Specialist

At least one week prior to commencement of work on the structure, the name and qualifications of the corrosion specialist shall be submitted to the Contract Administrator.

935.04.01.08 Test Results

Within 3 Business Days of the completion of the tests required, the results of all tests that are specified to be recorded shall be submitted in writing to the Contract Administrator.

Each test result shall be identified by the corresponding test location.

935.05 MATERIALS

935.05.01 General

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

935.05.02 Concrete Pad for Cathodic Protection

Concrete pad for cathodic protection shall be according to OPSS 616.

935.05.03 Cathodic Protection System

Cathodic protection system and its associated materials shall be supplied according to OPSS 2301.

935.05.04 Concrete for Blockout

Concrete used to fill blockouts for installation of cables in curbs, sidewalks, and barrier walls shall have a 28-Day strength of 30 MPa according to OPSS 1350. Nominal maximum size of aggregate shall be 9.5 mm.

935.05.05 Water

Water shall be according to OPSS 1302.

935.05.06 Non-Shrink Grout

Non-shrink grout shall be supplied from a source named on the ministry's DSM.

935.05.07 Spacer Grid

The spacer grid shall be according to OPSS 2301.

935.06 EQUIPMENT

935.06.01 AC Resistance Meter

The AC resistance meter shall be capable of measuring from 0.1 to 10,000 ohms, with an accuracy of ± 1 % of full scale, and shall be insensitive to AC and DC ground currents.

935.06.02 Multimeter

The multimeter shall have an input impedance of not less than 10 megohms when operated at a full scale of 100 mV DC.

The meter shall have an accuracy of ± 2.5 % of the reading in DC volts with a resolution of 0.1 mV.

935.06.03 Clamp-On Ammeter

The clamp-on ammeter shall be capable of measuring DC current ranging from 1 to 4,000 mA.

The ammeter shall measure DC current with an accuracy of $\pm 2.0\%$ and a resolution of 1 mA.

935.06.04 Air Compressor - Air Blasting

The air compressor for air blasting shall have a minimum capacity of 3.5 m³/min. The compressed air shall be free of oil according to ASTM D 4285-83 and be forced through a nozzle at a minimum pressure of 300 kPa.

935.06.05 Pressure Wash Equipment

The pressure wash equipment shall produce a minimum pressure at the nozzle of 1.4 MPa.

935.06.06 Holiday Detector

The holiday detector shall have pulse type output voltages adjustable to produce from 300 to 3,000 volts. The device shall be equipped with a 300 mm wide conductive steel or copper brush to scan the concrete surface and shall produce a loud audible signal when metals that are electrically connected to the reinforcement are detected.

935.06.07 Concrete Cover Meter

The cover meter shall have a digital read out for measurement of cover and an audio signal indicating detection of reinforcing steel bars in concrete with cover up to 150 mm. The accuracy of the meter shall be $\pm 5\%$ of full scale.

935.06.08 Resistance Welder

The resistance welder shall be as recommended by the anode system manufacturer.

935.07 CONSTRUCTION

935.07.01 General

935.07.01.01 Sequence of Work

The cathodic protection work shall not commence until the repairs in the areas to receive cathodic protection have been completed fully or in sections and accepted by the Contract Administrator.

935.07.01.02 Access

The Contract Administrator shall have full access to the place of manufacture of the cathodic protection control and monitoring equipment.

935.07.01.03 Electrical

All electrical work shall be as specified in the Contract Documents.

All resistance measurements shall be made with an AC resistance meter, except when measuring resistance between two cathode connections.

935.07.01.04 Concrete Removal in Recesses and Cable Slots

The recesses for the embedded components and cable slots shall be sawcut prior to concrete removal. Concrete removal shall be according to OPSS 928.

935.07.01.05 Abrasive Blast Cleaning

Abrasive blast cleaning shall be according to OPSS 929.

935.07.01.06 Concrete Placement

Concrete shall be placed according to OPSS 904.

935.07.01.07 Curing

Curing of concrete and non-shrink grout shall be according to OPSS 904 utilizing the wet burlap method.

935.07.02 Cathode Connections

935.07.02.01 Installation

935.07.02.01.01 Scheduling

Cathode connections to the reinforcing steel shall be made after removal of concrete and abrasive blast cleaning in the removal areas.

935.07.02.01.02 Layout

The cathode CS and CM cables shall be connected to the reinforcing steel at the locations as specified in the Contract Documents. Alternative locations for cathode CS and CM connections shall be specified by the Contract Administrator, if required.

Adjustment up to 1 m shall be allowed for the cathode CS connections. The cathode CM connections shall be located between 600 mm and 1 m of the respective reference cells.

At the cathode connection positions specified, the location of the reinforcing steel bars shall be determined by means of a cover meter.

935.07.02.01.03 Preparation of Reinforcement and Recess

Concrete shall be removed to expose a 150 mm length of reinforcing bar.

The reinforcing steel and the concrete surface of the recess shall be abrasive blast cleaned and cleaned of all deleterious material by means of air blasting.

The reinforcing bar shall be ground locally to expose bare metal prior to making the thermite weld connection.

935.07.02.01.04 Connection of Reinforcing Steel

The connection shall be made centred on the ground portion of the reinforcing steel as specified in the Contract Documents. The bare portion of the cathode cable shall be protected by a copper sleeve and shall be connected by thermite welding to the reinforcing bar. Mechanical connections shall not be used.

When the weld has cooled, slag shall be removed and a 5 mm thick layer of silicone sealant shall be applied to the entire weld area of the bar and to all exposed copper cable. After setting of the silicone seal, all debris shall be removed from the recess and the surface of the recess shall be dampened. All free water shall be removed from the recess and the recess shall be filled with non-shrink grout according to the manufacturer's recommendations.

935.07.02.01.05 Cable Installation

Cable slots shall be created by saw cutting. Cable slots, each 6 mm wide by 10 mm deep, shall be sawn between the cathode connection locations and the junction box for the installation of cathode connection cables as specified in the Contract Documents. The edges of the slot shall be rounded where the slot meets the recess. Each slot shall contain only one cable.

When multiple cables converge in to one cable slot, the cable slot shall be adjusted to 9 mm wide by 23 mm deep and sawn from the point where all the cables converge at the install area to the corresponding junction box. Each cable shall share the common saw slot running to the junction box.

Immediately prior to placing material, the recesses shall be abrasive blast cleaned and all deleterious material contained inside the recesses and slots shall be removed by means of air blasting.

The cable shall be continuously contained in the slot between the cathode connection and the junction box and held in place with non-metallic plugs spaced at 600 mm on centres to prevent migration of the cable towards the surface.

Cables that will be unconnected at the junction box location for more than one week shall have a heat shrink end boot installed until the permanent connection is made.

Cable slots shall be backfilled with non-conductive low viscosity epoxy to the level of the original concrete surface according to the manufacturer's recommendations. Care shall be exercised to ensure that the slots are completely filled with epoxy and there is no excess epoxy spilled over the adjacent concrete surface along the slots.

935.07.02.01.06 Testing During Installation

Prior to filling cathode recesses, the mechanical soundness of each completed cathode connection shall be verified and the DC resistance and voltage between the ends of cables from cathode connections shall be measured and recorded.

The resistance between any two cathode connection cables in a single zone shall be less than 1.0 ohm and voltage shall be less than 1 mV. If the resistance is greater than 1.0 ohm, or voltage is greater than 1 mV, each individual cathode connection cable shall be checked and remedial work shall be performed as follows:

- a) When the resistance between the end of the cable and the reinforcing bar to which it is connected is greater than 1.0 ohm or the voltage is greater than 1 mV, the cable shall be cut and reattached to the same reinforcing bar at least 150 mm away from the previous connection.
- b) When the resistance between the end of the cable and the reinforcing bar to which it is connected is less than 1.0 ohm and voltage is less than 1 mV, additional cathode connections shall be installed at locations determined by the Contract Administrator.

Resistance and voltage measurements between pairs of cathode connection cables shall be repeated and recorded following remedial work.

When mechanical soundness of the cathode connections and continuity of reinforcing steel have been verified, patching of cathode cavities may proceed. After patches are placed, the resistance and voltage between pairs of cathode connection cables shall be measured and recorded to check the connections prior to placing anode.

The results of all tests shall be certified by the corrosion specialist and the certified test results shall be submitted to the Contract Administrator.

935.07.03 Reference Cells - Graphite and Silver-Silver Chloride

935.07.03.01 Installation

935.07.03.01.01 Scheduling

The recesses for reference cells and cable slots shall be saw cut prior to concrete removal.

Reference cells shall be installed after removal of concrete and abrasive blast cleaning in the removal areas.

935.07.03.01.02 Layout

The reference cells shall be placed at the locations as specified in the Contract Documents.

At the reference cell positions as specified in the Contract documents, the location of the reinforcing steel bars shall be determined by means of a cover meter.

A recess, 200 mm wide by 400 mm long, to accommodate the reference cell shall be cut into the concrete within 10 to 25 mm from a reinforcing steel bar with the longitudinal axis of the cell parallel to the reinforcing steel bar. The Contract Administrator may specify a smaller size recess, if necessary.

When reinforcing steel interferes with the placement of a cell, the recess shall be extended to permit installing the cell without cutting the reinforcing steel or a new recess shall be cut.

Reference cells shall not be positioned in a patched area or within 600 mm of a patched area.

To comply with the above requirements the cell may be moved a maximum of 1 m from the location as specified in the Contract Drawings.

The Contract Administrator shall specify alternative locations when the above conditions cannot be satisfied or when required.

935.07.03.01.03**Preparation of Recess and Cell Placement**

The depth of the recess shall permit the reference cell to be installed with the adjacent reinforcing steel bar at the mid height of the cell. When 10 mm of cover is not provided to the top of the cell under the above conditions, the recess shall be deepened to provide the 10 mm of cover.

Reference cells installed adjacent to ducts containing post-tensioning steel shall be installed at the depth as specified in the Contract Documents or as directed by the Contract Administrator.

The concrete surface in the recess shall be abrasive blast cleaned and all deleterious material removed by means of air blasting.

The surfaces of the recess shall be dampened, all free water removed, and coated with non-shrink grout. The reference cell shall be placed tight against the side of the recess closest to the reinforcing steel; however, contact between the cell and the exposed reinforcing steel shall not be permitted. The recess, including cavities induced by saw cutting shall be filled with non-shrink grout according to the manufacturer's recommendations to the level of the original concrete surface.

935.07.03.01.04**Cable Installation**

Cable slots shall be created by saw cutting. Cable slots, each 6 mm wide by 10 mm deep, shall be sawn between the reference cell recess and the junction box for the installation of the reference cell cables as specified in the Contract Documents. The edges of the slot shall be rounded where the slot meets the recess. Each slot shall contain only one cable.

When multiple cables converge in to one cable slot, the cable slot shall be adjusted to 9 mm wide by 23 mm deep and sawn from the point where all the cables converge at the install area to the corresponding junction box. Each cable will share the common saw slot running to the junction box.

Immediately prior to placing material, the recesses shall be abrasive blast cleaned and all deleterious material contained inside the recesses and slots shall be removed by means of air blasting.

The cable shall be continuously contained in the slot between the reference cell recess and the junction box and held in place with non-metallic plugs spaced at 600 mm on centres to prevent migration of the cable towards the surface.

Each cable left unconnected at the junction box location for more than 1 Day shall have a heat shrink end boot installed on it. The heat shrink end boot shall not be removed until the cable is permanently connected.

Cable slots shall be backfilled with non-conductive low viscosity epoxy to the level of the original concrete surface according to the manufacturer's recommendations. Care shall be exercised to ensure that the slots are completely filled with epoxy and there is no excess epoxy spilled over the adjacent concrete surface along the slots.

935.07.03.01.05**Testing During Installation**

Upon completion of cell installation, the voltage and resistance between the reference cell and the cathode CM connection shall be measured and recorded.

If the AC resistance between the graphite cell and the cathode connection is less than 10 ohms or more than 1,000 ohms or if the voltage reading is unstable, the cell shall be removed and replaced. The voltage and resistance measurements shall be repeated and recorded.

The results of all tests shall be certified by the corrosion specialist and the certified test results shall be submitted to the Contract Administrator.

935.07.04**Rigid Ducts and Junction Boxes, Surface Mounted**

The duct, fittings, and junction boxes shall be installed in neat straight lines. Rigid ducts shall be installed vertically and either horizontally or parallel to structural surfaces using offset bends or fittings where changes in alignment are necessary. When holes are specified to permit installation through concrete components, they shall be core drilled.

Expansion joints shall be installed according to the manufacturer's recommendations with at least one expansion joint between any two adjacent junction boxes. Conduit straps and junction boxes shall be fastened to the concrete surface by drilling and inserting stainless steel anchors and bolts.

Conduit straps shall be located at a maximum of 1.5 m centres and shall be one trade size larger than the conduit supported.

Ducts and junction boxes shall be installed after concrete repairs have been completed.

935.07.05**Rigid Ducts and Junction Boxes, Embedded in Concrete**

The installation of rigid PVC junction boxes and rigid duct embedded in concrete shall be according to OPSS 913.

When cables are to be routed through the curb to a junction box mounted on the outside face of a deck, concrete shall be removed at the curb locations to the width and depth as specified in the Contract Documents. All sharp edges of concrete shall be rounded off. A hole shall be drilled to provide access to the junction box or to provide a deck entry hole where specified in the Contract Documents. A non-conductive duct shall be installed and grouted in place with non-shrink grout.

After the installation of the cables, the duct embedded in the curb shall be sealed with a silicone plug to a depth of 50 mm.

The cavities in the curb, barrier wall, or sidewalk shall be filled with concrete to the original surface according to OPSS 930.

935.07.06**Rigid Ducts, Direct Buried**

The installation of rigid ducts direct buried shall be according to OPSS 603.

935.07.07**Extra Low Voltage Cables**

The installation of the extra low voltage cables shall be according to OPSS 604.

The run of extra low voltage cable from the initial splice in the junction box to the cathodic protection cabinet shall be of one continuous length. Heat shrink identification sleeves shall be placed over the free end of each cable at the cathodic protection cabinet and at the end of each cable from the structure in the junction boxes with the number of the component as specified in the Contract Documents.

All splices, with the exception of anode distribution bars, shall be made in the junction boxes with compression connectors. Each splice shall be soldered after installation. Both ends of the connector shall be soldered to the cable.

All splices for reference cells and cathode CM cables shall be sealed and insulated with heat shrink tubing. The splices for the cathode CS cables shall be sealed and insulated with a motor splice kit.

Cable that will be unconnected at the junction box location for more than one week shall have a heat shrink end boot installed until the permanent connection is made.

935.07.08 Installation of Cathodic Protection Equipment Assembly

935.07.08.01 Concrete Pad and Ground Electrode

The concrete pad shall be constructed according to OPSS 616, except that the anchor bolts shall be drilled in place.

The installation of the ground wires and ground electrode shall be according to OPSS 609.

935.07.08.02 Installation of Cabinet

The pedestal and cabinet shall be installed squarely and symmetrically on the concrete pad with a neoprene gasket installed on the bottom channel of the enclosure and the bottom of the pedestal.

Holes for mounting bolts shall be drilled, as required, and anchor bolts installed.

935.07.08.03 Grounding

The ground bar installed on the inside and bottom part of the cabinet shall be connected to the system ground as specified in the Contract Documents.

935.07.08.04 Connection of Incoming Cables

The AC power supply shall be connected to the AC power distribution assembly. Each cable from the structure shall be connected to the proper terminal on the terminal block assembly conforming to the colour code and labelling.

Upon completion of wiring and connection, all incoming cables shall be bundled and held in place with nylon cable ties. Cables and connectors shall not be subject to stress during or after installation.

935.07.09 Anode Mesh and Distribution Bars

935.07.09.01 Handling and Storing

The anode mesh and distribution bars shall be handled and stored in such a manner to avoid breakage or shape distortion due to stretching. The anode mesh and distribution bar shall be kept clean and dry prior to installation.

935.07.09.02 Installation

935.07.09.02.01 Scheduling

The anode mesh and distribution bars shall be installed after all concrete patching and abrasive blast cleaning of the concrete surface has been carried out and prior to placement of the concrete overlay.

935.07.09.02.02 Layout

The anode mesh and distribution bars shall be installed on the concrete surfaces as specified in the Contract Documents. Alternative arrangement of anode mesh rows may be considered where it may be practical to use odd shapes of anode mesh, subject to the approval of the Contract Administrator.

935.07.09.02.03 Isolation

The anode mesh and distribution bars shall be electrically isolated from the reinforcing steel and from any metallic components on the surface of the structure prior to proceeding with the work. Only non-metallic fasteners shall be used.

When a deck has been scarified, a concrete cover survey on a 1.5 x 1.5 m grid shall be done after scarifying and prior to the installation of the anode mesh. The results of the survey shall be recorded and submitted to the Contract Administrator.

A spacer grid shall be placed between the anode mesh and distribution bars and the concrete in areas where cover to the reinforcing steel is less than 15 mm or with exposed reinforcing steel. The spacer grid GFRP bars shall be tied together with plastic ties thereby holding the grid together and secured to prevent bars from floating during the overlay pour. Non- conductive fasteners similar to those used to anchor the titanium mesh shall be used to secure the bars to the deck. The titanium mesh in the secured areas shall be placed on top of the GFRP grid and tied by plastic ties to the grid.

Exposed rebars shall not be protected with a coating of grout or epoxy as a means of isolation.

Immediately prior to installation of the anode mesh, all concrete surfaces shall be inspected for exposed metal such as tie-wire, tie-rods, bolts, and other metallic components. All exposed metal and metal within 5 mm of the concrete surface, which is continuous with the reinforcing steel, shall be identified by visual means and by means of a holiday detector and the metal shall be insulated by coating with two coats of epoxy or shall be removed as directed by the Contract Administrator. When epoxy is used, only the metal shall be coated.

935.07.09.02.04 Anode Mesh Placement

Adjacent rolls of anode mesh within the same zone shall be in contact with a minimum overlap of 100 mm.

When two or more zones or subzones are specified, the separation between anode mesh in adjacent zones or subzones shall be 150 ± 25 mm.

Anode mesh shall be cut, where necessary, to provide a separation of 150 ± 25 mm between the anode mesh and metal features mounted on or protruding from concrete surface.

At splices and at joints where irregularly shaped sections are added, the anode mesh shall be overlapped a minimum of 75 mm and both sections of the anode mesh shall be welded to the distribution bar.

The anode mesh shall be either offset a maximum of 75 mm from a concrete corner or shall be wrapped tightly around the corner.

The edge of anode mesh shall be offset 150 ± 25 mm from the curb face throughout the length of the deck.

The location of embedded cables shall be determined and marked on the concrete prior to drilling for fasteners.

The anode mesh shall be held in place by non-conductive fasteners inserted in drilled holes. There shall be at least three fasteners installed across the full width of each roll of the anode mesh such that two anchors are placed 50 to 75 mm from the anode mesh edge with a third anchor in the centre. The maximum distance between two adjacent anchors along the length and width of the anode mesh shall not exceed 600 mm.

When the anode mesh is elevated as a result of the GFRP spacer grid, the mesh shall be secured to the GFRP bars by plastic ties.

Overlapping anode mesh may be attached with a common fastener.

The anode mesh shall be installed as close to the concrete surface as practical with a maximum offset from the surface of 3 mm.

Bulges shall be pressed down and additional fasteners shall be installed to maintain the specified clearance.

The anode mesh shall not be tensioned to such an extent that the anode mesh pattern is distorted. Edges of anode mesh cut to avoid contact with objects on the concrete surface shall be fastened at no more than 300 mm intervals.

All debris and dirt resulting from drilling holes for fasteners and others work associated with the installation of the anode mesh shall be removed from the concrete surface by air blasting at a minimum frequency of once per Day.

Under no circumstances shall the anode mesh be subjected to abrasive blast cleaning.

935.07.09.02.05 Distribution Bar Placement

Distribution bars shall be installed in straight lines as specified in the Contract Documents. The locations shall line up with junction box locations to facilitate connection within the box.

Where specified, distribution bars may be extended by overlapping approximately 200 mm and resistance welding every 12 mm.

The anode mesh shall be resistance welded to the distribution bars at every third diamond intersection point for a spacing of approximately 228 mm.

The welding procedures used shall be according to the anode mesh manufacturer's recommendations and shall be those used in making the samples for submission.

The distribution bars shall be protected by the application of heat-shrinkable tubing:

- a) in conduit connecting to junction box.
- b) where passing through curb.
- c) where traversing concrete cracks greater than 1 mm.
- d) where specified in the Contract Documents or by Contract Administrator.

The distribution bars shall enter the junction box through the conduit as specified in the Contract Documents. The two distribution bars shall be jumpered by a short stub of distribution bar resistance welded to them in the junction box.

The distribution bars shall be connected to the anode bus cables in the junction box by means of a bolted connector as specified in the Contract Documents. The threads of the bolt shall be coated with a locking compound. The connection and any exposed distribution bars shall be sealed and insulated with heat shrink tubing and heat shrink tape.

935.07.09.02.06 Concrete Surface Preparation after Anode Installation

Immediately after installation of the anode mesh and distribution bars, all debris resulting from the drilling of anchor holes and other accumulated dirt shall be removed from the concrete surface by air blasting.

The surface of the concrete with anode mesh and distribution bars in place shall be pre-wetted with water prior to application of the concrete overlay.

935.07.09.02.07 Protection during Placement of Concrete Overlay

During placement of concrete overlay, the anode mesh and distribution bars shall be protected against potential damage caused by construction equipment and workers by means of 20 mm thick plywood sheeting. The plywood sheets shall be removed as the placement of the overlay progresses.

935.07.09.02.08 Junction Box Entry

When wiring is to be routed to junction boxes embedded in new barrier walls or sidewalks, a blackout shall be created to permit installation of conduit and wiring.

After installation of the cables, the conduit in the curb shall be sealed with a silicone plug to a depth of 50 mm.

The cavities in the curb, barrier wall, or sidewalks shall be filled with concrete to the original surface according to OPSS 930. Alternatively, the cavity may be filled with non-shrink grout.

935.07.09.03 Testing

935.07.09.03.01 Pre-Installation

Prior to installing anode mesh and distribution bars, the quality of the weld between the anode mesh and current distribution bar shall be pull tested by preparing a sample weld and pulling the anode mesh from the distribution bar using pliers. If metal is pulled from one substrate, the weld is acceptable. If the anode mesh strand or strip breaks or is burned through, the weld power setting is too high. If the weld breaks, the power setting is too low. A similar test shall be carried out to determine the quality of the weld when two distribution bars are welded together. The weld power setting shall be adjusted to obtain satisfactory welds.

One week prior to the commencement of the installation of the distribution bars and the anode mesh, the following samples fabricated with the equipment and procedures to be used in the work together with the power setting used in welding the samples shall be submitted to the Contract Administrator:

- a) Two 300 mm lengths of distribution bars overlapped and welded at four locations at 12 mm intervals.
- b) Anode mesh weld at the diamond junctions to two 500 mm lengths of distribution bars.

935.07.09.03.02 During Installation

935.07.09.03.02.01 Weld between Anode Mesh and Distribution Bars

During installation of the anode mesh and distribution bars, random pull tests shall be performed on the weld connecting as follows to verify the adequacy of the welds:

- a) The anode mesh to the distribution bar.
- b) The distribution bar to the distributor bar.

935.07.09.03.02.02 Short Circuits

Tests for short circuits shall be carried out by the corrosion specialist or a NACE accredited cathodic protection or corrosion technologist under the direct supervision of the corrosion specialist.

Tests for short circuits between the anode mesh, distribution bars, the reinforcing steel, and all metallic appurtenances shall be done during installation of the anode mesh and continuously monitored during application of the concrete overlay.

Short circuits shall be removed and the area retested prior to proceeding with the concrete overlay.

When the area of potential short circuits is equal to or less than 150 x 150 mm, the anode mesh shall be cut clear of the exposed reinforcing steel or in areas where the cover to the reinforcing steel is less than 15 mm. When the area of potential shorts circuits is greater than 150 x 150 mm, the anode mesh shall be separated from the concrete surface using a GFRP spacer grid.

The location and extent of the areas requiring treatment and the treatment undertaken to eliminate the short circuit shall be recorded and submitted to the Contract Administrator.

Prior to installation of the waterproofing on the concrete overlay and at each stage, a test shall be done to confirm that there are no short circuits by temporarily applying a direct current using a portable DC power supply sufficient to produce and applied current density of 10 mA/m². When the occurrence of a short circuit is detected, the short circuit shall be located and removed.

The results of all tests shall be certified by the corrosion specialist and the certified test results shall be submitted to the Contract Administrator.

935.07.09.04 Trial Operating Period - Acceptance Testing

935.07.09.04.01 General

Prior to the acceptance of the Work, it shall be demonstrated that all components of the cathodic protection system, including the rectifier and RMU, are in proper working order. Short circuits are not permitted between the anode mesh and its hardware and the reinforcing steel or any other metallic components of the structure in contact with the reinforcing steel, such as drainage pipe or expansion joints.

Field readings taken during the trial operating period shall be taken by a NACE accredited cathodic protection or corrosion technologist under the direct supervision of the corrosion specialist.

The system shall be energized for a period of 72 hours at a power level that applies an average current density of 2 mA/m² on all cathodically protected areas of the structure. If AC power is not available at the site at the time of the trial operating period, power shall be provided to the rectifier and remote monitoring by means of a portable generator.

Field testing of the installed cathodic protection system shall only be conducted with the Contract Administrator and a representative of the Owner in attendance.

The Contract Administrator shall be informed 4 Business Days in advance of the planned trial operating period.

When measuring the potential of reference cells, the negative lead of the multimeter shall be connected to the reference cell lead wire and the positive lead to the cathode CM wire. The polarity sign of the reading shall be recorded.

Testing shall be done when the air temperature is at least 5 °C.

The results of all tests shall be certified by the corrosion specialist and the certified test results shall be submitted to the Contract Administrator.

A training session for the demonstration of the use of the RMU software including downloading of site data shall be carried out at the ministry's Bridge Office in St. Catharines.

935.07.09.04.02 Testing Prior to Energizing the System

935.07.09.04.02.01 Embedded Components

Immediately prior to energizing the system, the following measurements shall be manually recorded on site at the cathodic protection cabinet with a portable multimeter and AC resistance meter:

- a) Reference cell potential, in mV, relative to cathode CM cable.
- b) Voltage between each anode or anode bus and cathode CS cable, in volts.
- c) Resistance, AC, between each reference cell and cathode CM cable, in ohms.
- d) Resistance, AC, between each anode or anode bus and cathode CS cable, in ohms.
- e) Resistance, DC, between CM and CS cathode connections, in ohms.
- f) Voltage between CM and CS cathode connections, in mV.

To meet the requirements of this specification, the readings obtained shall be according to requirements as shown in Table 1.

935.07.09.04.02.02 Rectifier

It shall be demonstrated in the presence of the Contract Administrator that the rectifier assemblies will function properly throughout the full operating range of the output current and voltage according to OPSS 2301. The rectifier assemblies shall not be connected to the cathodic protection system at the time the testing is conducted.

935.07.09.04.02.03 Remote Monitoring and Control Unit

It shall be demonstrated in the presence of the Contract Administrator that the operation of the RMU meets the requirements according to OPSS 2301.

935.07.09.04.03 Testing after Energizing the System

After the system is energized, the following readings shall be manually recorded on site at the cathodic protection cabinet for a period of 72 hours using a portable multimeter and clamp-on ammeter.

- a) Total current and voltage for each rectifier.
- b) Current flow to each area of the system, zones or subzones or both, or anode bus, as applicable.
- c) Reference cell potentials, on and instant-off.

Manual readings shall be verified with portable computer on site connected to the RMU and at a computer located at a remote location.

The manual readings and the RMU readings from the portable computer on site shall be taken on an hourly basis during the work hours and the readings obtained from the remote location computer shall be taken on an hourly basis.

All the measurements obtained by the RMU shall be the same as the readings obtained manually on site. The RMU shall be calibrated using gains and offsets, as required.

The results of all tests shall be certified by the corrosion specialist and the certified test results shall be submitted to the Contract Administrator.

Immediately after the 72-hour readings are made, the system shall be switched off and allowed to depolarize for a period of 4 hours. At the end of the 4-hour depolarization period, reference cell potentials shall be recorded and the differences between instant-off readings at 72 hours and the 76-hour depolarized readings shall be calculated. Voltage between anodes and cathode shall also be recorded.

The performance of the system shall be monitored during the trial operating period and appropriate actions shall be taken to repair any defects detected. The trial operating period shall be repeated as many times as required to prove proper functioning of the system.

Within 7 Days of the completion of the trial operating period, an acceptance testing commissioning report shall be submitted to the Contract Administrator recording:

- a) The dates and times of the periods of trial operation.
- b) Names of individuals collecting and recording data.
- c) Testing equipment used, manufacturer and model number, including power source, if applicable.
- d) All readings noted above, labelled as to appropriate zone, subzone, or bus, as applicable.
- e) All remedial action taken.

The acceptance testing commissioning report shall bear the seal and signature of the corrosion specialist and certify that:

- a) The rectifier and remote monitoring unit are functional.
- b) The wiring of the system is according to the Contract Drawings, and the labelling and identification of wire terminations is correct in the control panel.
- c) All areas, zones and subzones, or buses, as applicable, of the system were functional and received current flow during the trial operating period.
- d) There are no short circuits between anodes and cathodes.
- e) There are no short circuits between reference cells and cathode.
- f) The accuracy of all meters and proper circuit polarity has been verified using a multimeter.

935.07.10 Remedial Work

Work not meeting the acceptance testing requirements shall be repaired or replaced. Proposals for correcting deficiencies shall be submitted to the Contract Administrator for approval prior to commencement of the remedial work.

935.07.11 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

935.08 QUALITY ASSURANCE

935.08.01 Anode Mesh

A manual pull test will be randomly conducted on the weld connecting the anode mesh to the distribution bar to check the weld quality.

935.08.02 Control and Monitoring Equipment

The Contractor, through the agreement to purchase control and monitoring equipment, shall ensure the ministry's representative be permitted access to the place of assembly of the cathodic protection equipment assembly while work on the unit is being performed for the purpose of inspecting the work and examining plant records, certificates, materials being used, process of fabrication, and to request further tests, as required.

935.08.03 Acceptance and Rejection

Work not meeting the requirements of this specification shall be subject to rejection.

935.09 MEASUREMENT FOR PAYMENT

935.09.01 Actual Measurement

**935.09.01.01 Cathode Connections
Reference Cells
Cathodic Protection Cabinets
Concrete Pad for Cathodic Protection**

For measurement purposes, a count shall be made of each of the above items installed.

935.09.01.02 Anode Mesh

Measurement of anode mesh shall be by area in square metres for the full surface of the concrete being treated with no deduction for minor surface areas not covered, such as at corners, cutouts and the like, nor any addition for surface areas requiring overlapping mesh.

935.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

935.10

BASIS OF PAYMENT

935.10.01

Cathode Connections - Item
Reference Cells - Item
Cathodic Protection Cabinets - Item
Concrete Pads for Cathodic Protection - Item
Anode Mesh - Item
Extra Low Voltage Cables for Cathodic Protection - Item
Cathodic Protection Rectifiers - Item
Cathodic Protection Remote Monitoring and Control Units - Item
Rigid Ducts and Junction Boxes for Cathodic Protection - Item
Acceptance Testing for Cathodic Protection - 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
Resistance and Voltage Requirements

Component	Resistance Ohms	Voltage
Reference Cell - Graphite	10 - 1000 (AC)	Stable
Reference Cell - Silver-Silver Chloride	As per manufacturer's recommendations.	Stable
Cathode Connection	< 2 (DC)	< 1 mV
Anode	< 3 (AC)	Stable

Appendix 935-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

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.