

Ontario Provincial Standards for Roads and Public Works



- Volume 7 -

MUNICIPAL-ORIENTED

**OPS GENERAL CONDITIONS OF CONTRACT AND
GENERAL & CONSTRUCTION SPECIFICATIONS**



OPS is co-owned by the
Ministry of Transportation, Ontario
and the
Municipal Engineers Association



Municipal
Engineers
Association

MANUAL REVISION RECORD

Municipal-Oriented

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

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

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		
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9	APR 2015	Included in new manuals	35		
10	NOV 2015	Included in new manuals	36		
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REVISION INFORMATION SHEET

ONTARIO PROVINCIAL STANDARDS FOR ROADS AND PUBLIC WORKS

VOLUME 7 MUNICIPAL-ORIENTED OPS GENERAL CONDITIONS OF CONTRACT AND GENERAL AND CONSTRUCTION SPECIFICATIONS

MANUAL REVISION #12

NOVEMBER 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for use of Ontario Provincial Standards; therefore, manual holders are cautioned about immediately discarding superseded and cancelled standards.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 7

Remove the entire index and replace with the revised index.

Standard Specifications Volume 7

Superseded/Cancelled (Remove)		Revised/New (Insert)		Remarks
OPSS.MUNI	Dated	OPSS.MUNI	Dated	
		180	Nov 2016	“GENERAL SPECIFICATION FOR THE MANAGEMENT OF EXCESS MATERIALS” See Summary of Revisions.
		202	Nov 2016	“CONSTRUCTION SPECIFICATION FOR ROCK REMOVAL BY MANUAL SCALING, MACHINE SCALING, TRIM BLASTING, OR CONTROLLED BLASTING” This NEW specification was created to have MUNI version of the PROV 202 dated Nov 2013.
		302	Nov 2016	“CONSTRUCTION SPECIFICATION FOR PRIMING GRANULAR BASE” See Summary of Revisions.
		304	Nov 2016	“CONSTRUCTION SPECIFICATION FOR SINGLE AND DOUBLE SURFACE TREATMENT” See Summary of Revisions.
		305	Nov 2016	“CONSTRUCTION SPECIFICATION FOR GRANULAR SEALING” See Summary of Revisions.
314	Nov 2015	314	Nov 2016	“CONSTRUCTION SPECIFICATION FOR UNTREATED GRANULAR SUBBASE, BASE, SURFACE, SHOULDER AND STOCKPILING” This specification has been reaffirmed with no changes to technical information.

331	Nov 2015	331	Nov 2016	“CONSTRUCTION SPECIFICATION FOR FULL DEPTH RECLAMATION WITH EXPANDED ASPHALT STABILIZATION” See Summary of Revisions.
		332	Nov 2016	“CONSTRUCTION SPECIFICATION FOR HOT IN-PLACE AND HOT IN-PLACE RECYCLING WITH INTEGRAL OVERLAY” The entire specification has been rewritten in order to comply with the new MTO specification. TITLE, Updated to remove “...And Hot In-Place Recycling with Integral Overlay”.
		334	Nov 2016	“CONSTRUCTION SPECIFICATION FOR COLD RECYCLING MIX” See Summary of Revisions.
335	Nov 2015	335	Nov 2016	“CONSTRUCTION SPECIFICATION FOR COLD IN-PLACE RECYCLED EXPANDED ASPHALT MIX” See Summary of Revisions.
		353	Nov 2016	“CONSTRUCTION SPECIFICATION FOR CONCRETE CURB AND GUTTER SYSTEMS” See Summary of Revisions.
		402	Nov 2016	“CONSTRUCTION SPECIFICATION FOR EXCAVATING, BACKFILING AND COMPACTING FOR MAINTENANCE HOLES, CATCH BASINS, DITCH INLETS AND VALVE CHAMBERS” See Summary of Revisions.
		403	Nov 2016	“ROCK EXCAVATION FOR PIPELINES, UTILITIES AND ASSOCIATED STRUCTURES IN OPEN CUT” See Summary of Revisions.

		441	Nov 2016	“CONSTRUCTION SPECIFICATION FOR WATERMAIN INSTALLATION IN OPEN CUT” See Summary of Revisions.
		442	Nov 2016	“CONSTRUCTION SPECIFICATION FOR CORROSION PROTECTION OF NEW AND EXISTING WATERMAINS” See Summary of Revisions.
		517	Nov 2016	“CONSTRUCTION SPECIFICATION FOR DEWATERING” The MUNI implemented in November 2016 replaces OPSS 517 COMMON, November 2010 with no content changes.
		518	Nov 2016	“CONSTRUCTION SPECIFICATION FOR CONTROL OF WATER AND DEWATERING OPERATIONS” See Summary of Revisions.
		610	Nov 2016	“CONSTRUCTION SPECIFICATION FOR REMOVAL OF ELECTRICAL EQUIPMENT AND MATERIALS” See Summary of Revisions.
		630	Nov 2016	“CONSTRUCTION SPECIFICATION FOR INSTALLATION OF SECTIONAL STEEL HIGH MAST LIGHTING POLES” See Summary of Revisions.
		706	Nov 2016	“CONSTRUCTION SPECIFICATION FOR TEMPORARY CONTROL DEVICES” The MUNI implemented in November 2016 replaces OPSS 706 COMMON, November 2010 with no content changes.

721	Nov 2015	721	Nov 2016	“CONSTRUCTION SPECIFICATION FOR STEEL BEAM GUIDE RAIL AND CABLE GUIDE RAIL” See Summary of Revisions.
723	Nov 2015	723	Nov 2016	“CONSTRUCTION SPECIFICATION FOR ENERGY ATTENUATORS” See Summary of Revisions.
771	Nov 2014	771	Nov 2016	“CONSTRUCTION SPECIFICATION FOR STANDARD HIGHWAY FENCE” See Summary of Revisions.
		909	Nov 2016	“CONSTRUCTION SPECIFICATION FOR PRESTRESSED CONCRETE - PRECAST GIRDERS” The MUNI implemented in November 2016 replaces OPSS 909 COMMON, April 2012 with no content changes.
		922	Nov 2016	“CONSTRUCTION SPECIFICATION FOR INSTALLATION OF BEARINGS” The MUNI implemented in November 2016 replaces OPSS 922 COMMON, November 2009 with no content changes.

SUMMARY OF REVISIONS TO OPSS.MUNI 180

GENERAL SPECIFICATION FOR THE MANAGEMENT OF EXCESS MATERIALS

- Clause 180.04.01.04, Title “Certificate of” renamed to “Environmental Compliance” Approval. 1st paragraph modified.
- Subsection 180.07.05, Existing 3rd, 5th and 6th paragraphs deleted. Existing 4th paragraph modified.
- Subsection 180.07.07, Existing 2nd paragraph 1st sentence rewritten 2nd to 6th sentence deleted. Existing 4th, 15th and 16th paragraph deleted.
- Table 1, renamed to “Table A”
- Table 2, renamed to “Table B”
- Form, Site Selection Notification for Stockpiling Material Managed through Re-use, “Registered” added to Property Owner(s). Statement of registered owner(s) paragraph modified.
- Form, Site Selection Notification for Material Managed as Disposable Fill, “Registered” added to Property Owner(s). Statement of registered owner(s) paragraph modified.
- Form, Property Owner’s Release, Description line added for, “Quantity and Type of Excess Material used as fill:” and “Quantity and Type of Excess Material stockpiled:” Statement of registered owner(s) paragraph modified.

SUMMARY OF REVISIONS TO OPSS.MUNI 302

CONSTRUCTION SPECIFICATION FOR PRIMING GRANULAR BASE

- Title, Updated to remove “...And Hot In-Place Recycling with Integral Overlay”.
- Section 302.02.01, Specification Significance and Use, Updated for MUNI use.
- Section 302.01.02, Appendices Significance and Use, Updated for MUNI use.
- Section 302.02, References, Updated for MUNI use.
- Section 302.07.01, Operational Constraints, Updated to allow application of emulsified primer if needed.
- Appendix, Updated to ensure correct numbering of the referenced sections.

SUMMARY OF REVISIONS TO OPSS.MUNI 304

CONSTRUCTION SPECIFICATION FOR SINGLE AND DOUBLE SURFACE TREATMENT

- Section 304.02.01, Specification Significance and Use, Updated for MUNI use.
- Section 304.01.02, Appendices Significance and Use, Updated for MUNI use.
- Section 304.02, References, Updated for MUNI use.
- Section 304.07.02.01, Binder, Minor non-technical rewording.
- Appendix, Updated for MUNI use.

SUMMARY OF REVISIONS TO OPSS.MUNI 305

CONSTRUCTION SPECIFICATION FOR GRANULAR SEALING

- OPSS 305 has been revised extensively. It is recommended that users read the entire specification, as there are major differences between this version of the specification and previous versions.

SUMMARY OF REVISIONS TO OPSS.MUNI 331

CONSTRUCTION SPECIFICATION FOR FULL DEPTH RECLAMATION WITH EXPANDED ASPHALT STABILIZATION

- Section 331.02, References, Added reference to SP-027.
- NEW Section 331.08.03.01, Surface Appearance, New section added, and subsequent sections renumbered.

SUMMARY OF REVISIONS TO OPSS.MUNI 334

CONSTRUCTION SPECIFICATION FOR COLD RECYCLED MIX

- Section 334.02.01, Specification Significance and Use, Updated for MUNI use.
- Section 334.01.02, Appendices Significance and Use, Updated for MUNI use.
- Section 334.02, References, Updated for MUNI use.
- Section 334.02, References, Replaced SP-024 with SP-027.
- Section 334.07.01, Operational Constraints, Updated item a).
- Appendix, Updated for MUNI use.

SUMMARY OF REVISIONS TO OPSS.MUNI 335

CONSTRUCTION SPECIFICATION FOR COLD IN-PLACE RECYCLED EXPANDED ASPHALT MIX

- Section 335.02, References, Added reference to SP-027.
- Table 1, Rewritten to match OPSS.PROV 335 table.

SUMMARY OF REVISIONS TO OPSS.MUNI 353

CONSTRUCTION SPECIFICATION FOR CONCRETE CURB AND GUTTER SYSTEMS

- Section 353.02.01, Specification Significance and Use, Updated for MUNI use.
- Section 353.01.02, Appendices Significance and Use, Updated for MUNI use.
- Section 353.02, References, Updated for MUNI use.
- Section 353.05.01, Concrete, Rewritten.
- Section 353.07.08.01, Placement of Concrete, Updated.
- Section 353.07.12, Field Sampling and Testing of Concrete, Updated.
- Appendix, Updated to ensure correct numbering of the referenced sections.

SUMMARY OF REVISIONS TO OPSS.MUNI 402

CONSTRUCTION SPECIFICATION FOR EXCAVATING, BACKFILLING, AND COMPACTING FOR MAINTENANCE HOLES, CATCH BASINS, DITCH INLETS, AND VALVE CHAMBERS

- Section 402.01.01, Specification Significance and Use, Updated for MUNI use.
- Section 402.01.02, Appendices Significance and Use, Updated for MUNI use.
- Section 402.02, References, Updated for MUNI use.
- Section 402.05.02.02, Native and Imported Material, Boulders' dimension updated.
- Section 402.07.07, Removal of Frozen Ground, Added "Roadways".
- Appendix, Updated for MUNI use.
- Designer Action/Consideration, Updated to include reference use in 402.07.10.01.

SUMMARY OF REVISIONS TO OPSS.MUNI 403

CONSTRUCTION SPECIFICATION FOR ROCK EXCAVATION FOR PIPELINES, UTILITIES, AND ASSOCIATED STRUCTURES IN OPEN CUT

- Section 403.01.01, Specification Significance and Use, Updated for MUNI use.
- Section 403.02, References, Updated for MUNI use.
- Appendix, Updated for MUNI use.

SUMMARY OF REVISIONS TO OPSS 441

CONSTRUCTION SPECIFICATION FOR WATERMAIN INSTALLATION IN OPEN CUT

- Section 441.01.01, Specification Significance and Use, Updated for MUNI use.
- Section 441.01.02, Appendices Significance and Use, Updated for MUNI use.
- Section 441.02, References, Updated for MUNI use.
- Section 441.02, REFERENCES, OPSS 442 and MOECC's Disinfection Procedure added.
- Section 441.02, REFERENCES, All external references updated to the latest versions.
- Section 441.03, DEFINITIONS, Watermains definition updated.
- Section 441.05.01, Materials/General, Updated.
- Section 441.05.16, Corrosion Protection, New section added.
- Section 441.07.25, Flushing and Disinfecting Watermains, Rewritten to reference MOECC.
- Designer Actions/Commentary, Updated to remove reference to section 441.07.25 since it is no longer needed.
- Appendix, Updated for MUNI use.

SUMMARY OF REVISIONS TO OPSS.MUNI 442

CONSTRUCTION SPECIFICATION FOR CORROSION PROTECTION OF NEW AND EXISTING WATERMAINS

- Section 442.02, References, the typical wording "This specification refers to...publications" added.
- Section 442.02, References, CSA and ASTM standard versions updated to latest.
- Section 442.05.05, Test Stations, in part (b) the ability to specify lengths in Contract Documents added.
- Section 442.07.03, Anode Installation, section number corrected to 442.07.04.
- Section 442.07.04.02, Existing Metallic Watermains - Anode Bank Method, updated.
- Section 442.07.04.03, Existing Metallic Watermains - Exposed Pipe or Service Method, updated.
- Section 442.07.05, Corrosion Monitoring for Concrete Pressure Pipe, updated.
- Section 442.07.13, Testing and Evaluation, units updated.
- Designer Action/Considerations, updated to correct the section numbering discrepancy in 442.07.03.

SUMMARY OF REVISIONS TO OPSS.MUNI 518

CONSTRUCTION SPECIFICATION FOR CONTROL OF WATER FROM DEWATERING OPERATIONS

- Section 518.02, References, deletion of Fisheries Act, R.S., 1985 c. F-14.
- Section 518.03, Definitions, deletion of “Uncontaminated Water”.
- Section 518.03, Definitions, modified “Dewatering Operation”, “Sediment” and “Sediment Control”.
- Section 518.03, Definitions, renamed “Natural Attenuation” to “Vegetated Discharge” Area and modified.
- Subsection 518.07.01, Title “Disposal” renamed to “Discharge” of Water. 1st, 2nd paragraph modified, deleted 3rd paragraph and, addition of 4th and 5th paragraph.
- Existing Subsection 518.07.02 and 518.07.03, Surface Drainage, Settling Ponds and Sediment Traps or Basins deleted. Subsections reorder.
- Subsection 518.07.02, Title “Temporary Erosion and” renamed to “Discharge to” Sediment Control Measures.
- Subsection 518.07.03, Discharge to Vegetated Discharge Areas, new subsection.
- Subsection 518.07.04, Discharge to the Environment, new subsection.
- Subsection 518.07.06, Protection of Waterbodies and Waterbody Banks, new subsection.
- Appendix 518-A, 1st and 3rd paragraphs modified.
- Related Ontario Provincial Standard Drawings, OPSD 219.120 Light-Duty Fibre Roll Barrier, OPSD 219.131 Heavy-Duty Wire-Backed Silt Fence Barrier, OPSD 219.160 Fibre Roll Grade Breaks and OPSD 219.191 Fibre Roll Flow Check Dam added. OPSD 219.190 Silt Fence Flow Check Dam deleted.

SUMMARY OF REVISIONS TO OPSS.MUNI 610

CONSTRUCTION SPECIFICATION FOR REMOVAL OF ELECTRICAL EQUIPMENT AND MATERIALS

- Clause 610.04.01.01, f); Certificate of Approval revised to Environment Compliance Approval.
- Subsection 610.07.03 Removal, new 2nd paragraph added.

SUMMARY OF REVISIONS TO OPSS.MUNI 630

CONSTRUCTION SPECIFICATION FOR INSTALLATION OF SECTIONAL STEEL HIGH MAST LIGHTING POLES

- Section 630.02 References, CSA S6 updated.
- Appendix 630, Related Ontario Provincial Standards Drawings; OPSD 2450.010, OPSD 2450.020, OPSD 2452.010, OPSD 2452.020, and OPSD 2454.010 deleted; and OPSD 2453.001 added.

SUMMARY OF REVISIONS TO OPSS.MUNI 721

CONSTRUCTION SPECIFICATION FOR STEEL BEAM GUIDE RAIL AND CABLE GUIDE RAIL

- Section 721.02 References; ASTM A 36, ASTM A 780, and ASTM D 4956 updated.
- Clause 721.09.01.05, measurement for payment for Steel Beam Barricade added.
- Subsection 721.10.01, payment item for Steel Beam Barricade added.
- Appendix 721, Related Ontario Provincial Standards Drawings; OPSD 912.532 deleted and OPSD 973.130 added.

SUMMARY OF REVISIONS TO OPSS.MUNI 723

CONSTRUCTION SPECIFICATION FOR ENERGY ATTENUATORS

- New clause 723.07.03.01 added. Other clauses reordered.
- Subsection 723.09.01 Actual Measurement, measurement for payment for SLED System added.
- Subsection 723.10.01 Basis of Payment, payment item for SLED System added.
- Table 2, SLED System added.
- Appendix 723, Related Ontario Provincial Standards Drawings; OPSD 923.002, OPSD 923.010, and OPSD 923.011 added.

SUMMARY OF REVISIONS TO OPSS.MUNI 771

CONSTRUCTION SPECIFICATION FOR STANDARD HIGHWAY FENCE

- Clause 771.07.03.02.03, 1st paragraph, revised.
- Clause 771.07.03.04; 3rd paragraph revised, new 4th paragraph added, existing 6th paragraph revised.
- Appendix 771, Related Ontario Provincial Standards Drawings; OPSD 971.103 added.



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NOV 2014	363	Repairing Rigid Pavement with Precast Concrete Slabs
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NOV 2015	421	Pipe Culvert Installation in Open Cut
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NOV 2016	442	Corrosion Protection of New and Existing Watermains

DIVISION 5 - MISCELLANEOUS

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NOV 2014	510	Removal
NOV 2014	512	Installation of Gabions
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NOV 2016	610	Removal of Electrical Equipment and Materials



DATE	SPEC. NO. OPSS.MUNI	TITLE
NOV 2016	630	Installation of Sectional Steel High Mast Lighting Poles
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NOV 2016	723	Energy Attenuators
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NOV 2014	804	Seed and Cover
DIVISION 9 - STRUCTURAL		
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NOV 2014	905	Steel Reinforcement for Concrete
NOV 2014	908	Metal Traffic Barriers and Metal Railings for Structures
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OPS GENERAL CONDITIONS OF CONTRACT

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SECTION GC 1.0 - INTERPRETATION

GC 1.01 Captions

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

GC 1.02 Abbreviations

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

"AASHTO"	-	American Association of State Highway Transportation Officials
"ACI"	-	American Concrete Institute
"ANSI"	-	American National Standards Institute
"ASTM"	-	American Society for Testing and Materials
"AWG"	-	American Wire Gauge
"AWWA"	-	American Water Works Association
"CCIL"	-	Canadian Council of Independent Laboratories
"CESA"	-	Canadian Engineering Standards Association
"CGSB"	-	Canadian General Standards Board
"CSA"	-	Canadian Standards Association
"CWB"	-	Canadian Welding Bureau
"GC"	-	General Conditions
"ISO"	-	International Organization for Standardization
"MOE"	-	Ontario Ministry of the Environment
"MTO"	-	Ontario Ministry of Transportation
"MUTCD"	-	Manual of Uniform Traffic Control Devices (Replaced by OTM)
"OPS"	-	Ontario Provincial Standard
"OPSD"	-	Ontario Provincial Standard Drawing
"OPSS"	-	Ontario Provincial Standard Specification
"OTM"	-	Ontario Traffic Manual
"PEO"	-	Professional Engineers Ontario
"SAE"	-	Society of Automotive Engineers
"SCC"	-	Standards Council of Canada
"SSPC"	-	Structural Steel Painting Council
"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 Definitions

- .01 For the purposes of this Contract the following definitions apply:

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

Addendum means an addition or change in the tender documents issued by the Owner 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.

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

Base means a layer of material of specified type and thickness placed immediately below the pavement wearing surface layers, curb and gutter, or sidewalk.

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

Certificate of Subcontract Completion means the certificate issued by the Contract Administrator in accordance with clause GC 8.02.03.02, Certification of Subcontract Completion.

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

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

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

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

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

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

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

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

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

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

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

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

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

Cost Plus has the same meaning as "Time and Material."

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

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

Day means a calendar day.

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

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

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

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

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

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

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

Force Account has the same meaning as "Time and Material."

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

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

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

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

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

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

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

- a) \$100,000, 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.

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

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

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

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

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

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

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

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

Rate of Interest means the rate of interest as determined under the *Financial Administration Act* by the Minister of Finance of Ontario and issued by, and available from, the Owner.

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

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

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

Special Provisions mean directions containing requirements specific to the Work.

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

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

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

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

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

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

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

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

Time and Material means costs calculated according to clause GC 8.02.04, Payment on a Time and Material Basis. Where "Cost Plus" and "Force Account" are used they shall have the same meaning.

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

Warranty Period means the period of 12 months from the date of Substantial Performance or such longer period as may be specified in the Contract Documents for certain Materials or some or all of the Work. Where a date of Substantial Performance is not established, the Warranty Period shall commence on the date of Completion.

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

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

Working Day means any Day,

- a) except Saturdays, Sundays and statutory holidays;
- b) except a Day as determined by the Contract Administrator, on which the Contractor is prevented by inclement weather or conditions resulting immediately therefrom, from proceeding with a Controlling Operation. For the purposes of this definition, this shall be a Day during which the Contractor cannot proceed with at least 60% of the normal labour and Equipment force effectively engaged on the Controlling Operation for at least 5 hours;
- c) except a Day on which the Contractor is prevented from proceeding with a Controlling Operation, as determined by the Contract Administrator by reason of,
 - i. any breach of the Contract by the Owner or if such prevention is due to the Owner, another contractor hired by the Owner, or an employee of any one of them, or by anyone else acting on behalf of the Owner.
 - ii. non-delivery of Owner supplied Materials.
 - iii. any cause beyond the reasonable control of the Contractor that can be substantiated by the Contractor to the satisfaction of the Contract Administrator.

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

GC 1.05 Substantial Performance

- .01 The Work is substantially performed,
- a) when the Work to be performed under the Contract or a substantial part thereof is ready for use or is being used for the purpose intended; and
 - b) when the Work to be performed under the Contract is capable of completion or, where there is a known defect, the cost of correction, is 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 purposes 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 1.06 Completion

- .01 The Work shall be deemed to be completed and services or Materials shall be deemed to be last supplied to the Work when the price of completion, correction of a known defect, or last supply is not more than the lesser of,
- a) 1% of the Contract price; or
 - b) \$1,000.

GC 1.07 Final Acceptance

- .01 Final Acceptance shall be deemed to occur when the Contract Administrator is satisfied that, to the best of the Contract Administrator's knowledge at that time, the Contractor has rectified all imperfect work and has discharged all of the Contractor's obligations under the Contract.

GC 1.08 Interpretation of Certain Words

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

SECTION GC 2.0 - CONTRACT DOCUMENTS

GC 2.01 Reliance on Contract Documents

- .01 The Owner warrants that the information furnished in the Contract Documents can be relied upon with the following limitations or exceptions:
- a) The location of all mainline underground Utilities that may affect the Work shall be shown to a tolerance of:
 - i. 1 m horizontal, and
 - ii. 0.3 m vertical
- .02 The Owner does not warrant or make any representation with respect to:
- a) interpretations of data or opinions expressed in any Subsurface Report available for the perusal of the Contractor, whether or not such report is included as part of the Contract Documents, and
 - b) other information specifically excluded from this warranty.

GC 2.02 Order of Precedence

- .01 In the event of any inconsistency or conflict in the contents of the following documents, such documents shall take precedence and govern in the following descending order:
- a) Agreement
 - b) Addenda
 - c) Special Provisions
 - d) Contract Drawings
 - e) Standard Specifications
 - f) Standard Drawings
 - g) Instructions to Tenderers
 - h) Tender
 - i) Supplemental General Conditions
 - j) General Conditions
 - k) Working Drawings
- Later dates shall govern within each of the above categories of documents.
- .02 In the event of any conflict among or inconsistency in the information shown on Drawings, the following rules shall apply:
- a) Dimensions shown in figures on a Drawing shall govern where they differ from dimensions scaled from the same drawing;
 - b) Drawings of larger scale shall govern over those of smaller scale;

- c) Detailed Drawings shall govern over general Drawings; and
 - d) Drawings of a later date shall govern over those of an earlier date in the same series.
- .03 In the event of any inconsistency or conflict in the contents of Standard Specifications the following descending order of precedence shall govern:
- a) Owner's Standard Specifications
 - b) Ontario Provincial Standard Specifications
 - c) Other Standard Specifications, such as those produced by CSA, CGSB, ASTM, and ANSI and referenced in the Ontario Provincial Standard Specifications
- .04 The Contract Documents are complementary, and what is required by any one shall be as binding as if required by all.

SECTION GC 3.0 - ADMINISTRATION OF THE CONTRACT

GC 3.01 Contract Administrator's Authority

- .01 The Contract Administrator shall be the Owner's representative during construction and until the issuance of the Completion Certificate or the issuance of the Final Acceptance Certificate, whichever is later. All instructions to the Contractor, including instructions from the Owner, shall be issued by the Contract Administrator. The Contract Administrator shall have the authority to act on behalf of the Owner only to the extent provided in the Contract Documents.
- .02 All claims, disputes and other matters in question relating to the performance and the quality of the Work or the interpretation of the Contract Documents shall be referred to the Contract Administrator in writing by the Contractor.
- .03 The Contract Administrator may inspect the Work for its conformity with the Plans and Standard Specifications, 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 determine the amounts owing to the Contractor under the 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 shop drawings, product data, and samples in accordance with the Contract Documents.
- .06 The Contract Administrator shall investigate all allegations of a Change in the Work made by the Contractor and issue appropriate instructions.
- .07 The Contract Administrator shall prepare Change Directives and Change Orders for the Owner's approval.
- .08 Upon written application by the Contractor, the Contract Administrator and the Contractor shall jointly conduct an inspection of the Work to establish the date of Substantial Performance of the Work or the date of Completion of the Work or both.
- .09 The Contract Administrator shall be, in the first instance, the interpreter of the Contract Documents and the judge of the performance thereunder by both parties to the Contract. Interpretations and decisions of the Contract Administrator shall be consistent with the intent of the Contract Documents and, in making these decisions, the Contract Administrator shall not show partiality to either party.
- .10 The Contract Administrator shall have the authority to reject part of the Work or Material that does not conform to the Contract Documents.
- .11 In the event that the Contract Administrator determines that any part of the Work performed by the Contractor is defective, whether the result of poor workmanship; the use of defective material; or damage through carelessness or other act or omission of the Contractor and whether or not incorporated in the Work; or otherwise fails to conform to the Contract Documents, then the Contractor shall if directed by the Contract Administrator promptly remove the Work and replace, make good, or re-execute the Work at no additional cost to the Owner.
- .12 Any part of the Work destroyed or damaged by such removals, replacements, or re-executions shall be made good, promptly, at no additional cost to the Owner.

- .13 If, in the opinion of the Contract Administrator, it is not expedient to correct defective work or work not performed in accordance with the Contract Documents, the Owner may deduct from monies otherwise due to the Contractor the difference in value between the work as performed and that called for by the Contract Documents, the amount that will be determined in the first instance by the Contract Administrator.
- .14 Notwithstanding any inspections made by the Contract Administrator or the issuance of any certificates or the making of any payment by the Owner, the failure of the Contract Administrator to reject any defective work or Material shall not constitute acceptance of defective work or Material.
- .15 The Contract Administrator shall have the authority to temporarily suspend the Work for such reasonable time as may be necessary:
- a) to facilitate the checking of any portion of the Contractor's construction layout;
 - b) to facilitate the inspection of any portion of the Work; or
 - c) for the Contractor to remedy non-compliance in the case of such non-compliance with the provisions of the Contract by the Contractor.
- The Contractor shall not be entitled to any compensation for suspension of the Work in these circumstances.
- .16 The Owner has the right to terminate the Contract for wilful or persistent violation by the Contractor or its workers of the Occupational Health and Safety Act legislation and regulations, Workplace Safety and Insurance Board Act, and Regulation 309 of the Environmental Protection Act.
- .17 If the Contract Administrator determines that any worker employed on the Work is incompetent, as defined by the Occupational Health and Safety Act, or is disorderly, then the Contract Administrator shall provide written notice to the Contractor and the Contractor shall immediately remove the worker from the Working Area. Such worker shall not return to the Working Area without the prior written consent of the Contract Administrator.

GC 3.02 Working Drawings

- .01 The Contractor shall arrange for the preparation of clearly identified and dated Working Drawings as called for by the Contract Documents.
- .02 The Contractor 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. Working Drawings shall be submitted in printed form. At the time of submission the Contractor shall notify the Contract Administrator in writing of any deviations from the Contract requirements that exist in the Working Drawings.
- .03 The Contract Administrator shall review and return Working Drawings in accordance with an agreed upon schedule, or otherwise, with reasonable promptness so as not to cause delay.
- .04 The Contract Administrator's review shall be to check for conformity to the design concept and for general arrangement only and such review shall not relieve the Contractor of responsibility for errors or omissions in the Working Drawings or of responsibility for meeting all requirements of the Contract Documents, unless a deviation on the Working Drawings has been approved in writing by the Contract Administrator.

- .05 The Contractor shall make any changes in Working Drawings that the Contract Administrator may require to make the Working Drawings consistent with the Contract Documents and resubmit, unless otherwise directed by the Contract Administrator. When resubmitting, the Contractor shall notify the Contract Administrator in writing of any revisions other than those requested by the Contract Administrator.
- .06 Work related to the Working Drawings shall not proceed until the Working Drawings have been signed and dated by the Contract Administrator and marked with the words "Reviewed. Permission to construct granted."
- .07 The Contractor shall keep one set of the reviewed Working Drawings, marked as above, at the site at all times.

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

- .01 The Contractor shall, when requested in writing, make alterations in the method, Equipment, or work force at any time the Contract Administrator considers the Contractor's actions to be unsafe, or damaging to either the Work or existing facilities or the environment.
- .02 The Contractor shall, when requested in writing, alter the sequence of its operations on the Contract so as to avoid interference with work being performed by others.
- .03 Notwithstanding the foregoing, the Contractor shall ensure that all necessary safety precautions and protection are maintained throughout the Work.

GC 3.04 Emergency Situations

- .01 The Contract Administrator has the right to determine the existence of an emergency situation and, when such an emergency situation is deemed to exist, the Contract Administrator may instruct the Contractor to take action to remedy the situation. If the Contractor does not take timely action or, if the Contractor is not available, the Contract Administrator may direct others to remedy the situation.
- .02 If the emergency situation was the fault of the Contractor, the remedial work shall be done at the Contractor's expense. If the emergency situation was not the fault of the Contractor, the Owner shall pay for the remedial work.

GC 3.05 Layout

- .01 The Contract Administrator shall provide baseline and benchmark information for the general location, alignment, and elevation of the Work. The Owner shall be responsible only for the correctness of the information provided by the Contract Administrator.

GC 3.06 Extension of Contract Time

- .01 An application for an extension of Contract Time shall be made in writing by the Contractor to the Contract Administrator as soon as the need for such extension becomes evident and at least 15 Days prior to the expiration of the Contract Time. The application for an extension of Contract Time shall enumerate the reasons, and state the length of extension required.
- .02 Circumstances suitable for consideration of an extension of Contract Time include the following:
 - a) Delays, subsection GC 3.07.
 - b) Changes in the Work, clause GC 3.10.01.
 - c) Extra Work, clause GC 3.10.02.

- d) Additional Work, clause GC 3.10.03.
- .03 The Contract Administrator shall, in considering an application for an extension to the Contract Time, take into account whether the delays, Changes in the Work, Extra Work, or Additional Work involve a Controlling Operation.
- .04 The Contract Time shall be extended for such additional time as may be recommended by the Contract Administrator and deemed fair and reasonable by the Owner.
- .05 The terms and conditions of the Contract shall continue for such extension of Contract Time.

GC 3.07 Delays

- .01 If the Contractor is delayed in the performance of the Work by,
 - a) war, blockades, and civil commotions, errors in the Contract Documents;
 - b) an act or omission of the Owner or Contract Administrator, or anyone employed or engaged by them directly or indirectly, contrary to the provisions of the Contract Documents;
 - c) 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;
 - d) the Contract Administrator giving notice under subsection GC 7.10, Suspension of Work;
 - e) abnormal inclement weather; or
 - f) archaeological finds in accordance with subsection GC 3.15, Archaeological Finds,then the Contractor shall be reimbursed by the Owner for reasonable costs incurred by the Contractor as the result of such delay, provided that in the case of an application for an extension of Contract Time due to abnormal inclement weather, the Contractor shall, with the Contractor's application, submit evidence from Environment Canada in support of such application. Extension of Contract Time may be granted in accordance with subsection GC 3.06, Extension of Contract Time.
- .02 If the Work is delayed by labour disputes, strikes or lock-outs, including lock-outs decreed or recommended to its members by a recognized contractor's association, of which the Contractor is a member or to which the Contractor is otherwise bound, are beyond the Contractor's control, which then the Contract Time shall be extended in accordance with subsection GC 3.06, Extension of Contract Time. In no case shall the extension of Contract Time be less than the time lost as the result of the event causing the delay, unless a shorter extension is agreed to by the Contractor. The Contractor shall not be entitled to payment for costs incurred as the result of such delays unless such delays are the result of actions by the Owner.
- .03 The Contractor shall not be entitled to payment for the cost of delays incurred as a result of a dispute between the Contractor and Owner. The Contractor shall execute the Work and may pursue resolution of the dispute in accordance with subsection GC 3.13, Claims, Negotiations, Mediations.

GC 3.08 Assignment of Contract

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

GC 3.09 Subcontracting by the Contractor

- .01 The Contractor may subcontract any part of the Work, subject to these General Conditions and any limitations specified in the Contract Documents.
- .02 The Contractor shall notify the Contract Administrator 10 Days prior to the start of construction, in writing, of the intention to subcontract. Such notification shall identify the part of the Work, and the Subcontractor with whom it is intended.
- .03 The Contract Administrator shall, within 5 Days of receipt of such notification, accept or reject the intended Subcontractor. The rejection shall be in writing and shall include the reasons for the rejection.
- .04 The Contractor shall not, without the written consent of the Owner, change a Subcontractor who has been engaged in accordance with this subsection.
- .05 The Contractor shall preserve and protect the rights of the parties under the Contract with respect to that part of the Work to be performed under subcontract and shall,
 - a) enter into agreements with the intended Subcontractors to require them to perform their work in accordance with the Contract Documents; and
 - b) be as fully responsible to the Owner for acts and omissions of the Contractor's Subcontractors and of persons directly or indirectly employed by them as for acts and omissions of persons directly employed by the Contractor.
- .06 The Owner's consent to subcontracting by the Contractor shall not be construed to relieve the Contractor from any obligation under the Contract and shall not impose any liability upon the Owner. Nothing contained in the Contract Documents shall create a contractual relationship between a Subcontractor and the Owner.

GC 3.10 Changes

GC 3.10.01 Changes in the Work

- .01 The Owner, or the Contract Administrator where so authorized, may, by order in writing, make a Change in the Work without invalidating the Contract. The Contractor shall not be required to proceed with a Change in the Work until in receipt of a Change Order or Change Directive. Upon the receipt of such Change Order or Change Directive the Contractor shall proceed with the Change in the Work.
- .02 The Contractor may apply for an extension of Contract Time according to the terms of subsection GC 3.06, Extension of Contract Time.
- .03 If the Change in the Work relates solely to quantities, payment for that part of the Work shall be made according to the conditions specified in clause GC 8.01.02, Variations in Tender Quantities. If the Change in the Work does not solely relate to quantities, then either the Owner or the Contractor may initiate negotiations upwards or downwards for the adjustment of the Contract price in respect of the Change in the Work pursuant to subsection GC 3.13, Claims, Negotiations, Mediation or payment may be made according to the conditions contained in clause GC 8.02.04, Payment on a Time and Material Basis.

GC 3.10.02 Extra Work

- .01 The Owner, or Contract Administrator where so authorized, may instruct the Contractor to perform Extra Work without invalidating the Contract. The Contractor shall not be required to proceed with the Extra Work until in receipt of a Change Order or Change Directive. Upon receipt of such Change Order or Change Directive the Contractor shall proceed with the Extra Work.
- .02 The Contractor may apply for an extension of Contract Time according to the terms of subsection GC 3.06, Extension of Contract Time.
- .03 Either the Owner or Contractor may initiate negotiations upwards or downwards for the payment for the Extra Work pursuant to subsection GC 3.13, Claims, Negotiations, Mediation, or payment may be made according to the conditions contained in clause GC 8.02.04, Payment on a Time and Material Basis.

GC 3.10.03 Additional Work

- .01 The Owner, or Contract Administrator where so authorized, may request the Contractor to perform Additional Work without invalidating the Contract. If the Contractor agrees to perform Additional Work, the Contractor shall proceed with such Additional Work upon receipt of a Change Order.
- .02 The Contractor may apply for an extension of Contract Time according to the terms of subsection GC 3.06, Extension of Contract Time.
- .03 Payment for the Additional Work may be negotiated pursuant to subsection GC 3.13, Claims, Negotiations, Mediation, or payment may be made according to the conditions contained in clause GC 8.02.04, Payment on a Time and Material Basis.

GC 3.11 Notices

- .01 Any notice permitted or required to be given to the Contract Administrator or the Superintendent in respect of the Work shall be deemed to have been given to and received by the addressee on the date of delivery if delivered by hand, email, or by facsimile transmission and on the fifth Day after the date of mailing, if sent by mail.
- .02 The Contractor and the Owner shall provide each other with the mail and email addresses; pager, cell phone, and telephone numbers; and facsimile terminal numbers for the Contract Administrator and the Superintendent at the commencement of the Work, and update as necessary.
- .03 In the event of an emergency situation or other urgent matter the Contract Administrator or the Superintendent may give a verbal notice, provided that such notice is confirmed in writing within 2 Days.
- .04 Any notice permitted or required to be given to the Owner or the Contractor shall be given in accordance with the notice provision of the Contract.

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

- .01 Where it is not contemplated elsewhere in the Contract Documents, the Owner may use or occupy the Work or any part thereof prior to Substantial Performance, provided that at least 30 Days written notice has been given to the Contractor.
- .02 The use or occupancy of the Work or any part thereof by the Owner prior to Substantial Performance shall not constitute an acceptance of the Work or parts so occupied. In addition, the use or occupancy of the Work shall not relieve the Contractor or the Contractor's Surety from any liability that has arisen, or may arise, from the performance of the Work in accordance with the Contract

Documents. The Owner shall be responsible for any damage that occurs because of the Owner's use or occupancy. Such use or occupancy of any part of the Work by the Owner does not waive the Owner's right to charge the Contractor liquidated damages in accordance with the terms of the Contract.

GC 3.13 Claims, Negotiations, Mediation

GC 3.13.01 Continuance of the Work

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

GC 3.13.02 Record Keeping

- .01 Immediately upon commencing work that may result in a claim, the Contractor shall keep Daily Work Records during the course of the Work, sufficient to substantiate the Contractor's claim, and the Contract Administrator shall keep Daily Work Records to be used in assessing the Contractor's claim, all in accordance with clause GC 8.02.07, Records.
- .02 The Contractor and the Contract Administrator shall attempt to reconcile their respective Daily Work Records on a daily basis, to simplify review of the claim, when submitted. If the Contractor and the Contract Administrator fail to reconcile their respective Daily Work Records, then the Contractor shall submit its Daily Work Records as part of its claim, whereby the resolution of the dispute about the Daily Work Records shall not be resolved until there is a resolution of the claim.
- .03 The keeping of Daily Work Records by the Contract Administrator or the reconciling of such Daily Work Records with those of the Contractor shall not be construed to be acceptance of the claim.

GC 3.13.03 Claims Procedure

- .01 The Contractor shall give verbal notice of any situation that may lead to a claim for additional payment immediately upon becoming aware of the situation.
- .02 The Contractor shall provide written notice in the standard form "Notice of Intent to Claim" within 7 Days of the commencement of any part of the Work that may be affected by the situation.
- .03 The Contractor shall submit detailed claims as soon as reasonably possible and in any event no later than 30 Days after completion of the work affected by the situation. The detailed claim shall:
 - a) identify the item or items in respect of which the claim arises;
 - b) state the grounds, contractual or otherwise, upon which the claim is made; and
 - c) include the Records maintained by the Contractor supporting such claim.

In exceptional cases, the 30 Days may be increased to a maximum of 90 Days with approval in writing from the Contract Administrator.

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

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

GC 3.13.04 Negotiations

- .01 The parties shall make all reasonable efforts to resolve their dispute by amicable negotiations and agree to provide, without prejudice, open and timely disclosure of relevant facts, information, and documents to facilitate these negotiations.
- .02 Should the Contractor disagree with the opinion given in paragraph GC 3.13.03.05, with respect to any part of the claim, the Contract Administrator shall enter into negotiations with the Contractor to resolve the matters in dispute. Where a negotiated settlement cannot be reached and it is agreed that payment cannot be made on a Time and Material basis in accordance with clause GC 8.02.04, Payment on a Time and Material Basis, the parties shall proceed in accordance with clause GC 3.13.05, Mediation, or subsection GC 3.14, Arbitration.

GC 3.13.05 Mediation

- .01 If a claim is not resolved satisfactorily through the negotiation stage noted in clause GC 3.13.04, Negotiations, within a period of 30 Days following the opinion given in paragraph GC 3.13.03.05, and the Contractor wishes to pursue the issue further, the parties may, upon mutual agreement, utilize the services of an independent third party mediator.
- .02 The mediator shall be mutually agreed upon by the Owner and Contractor.
- .03 The mediator shall be knowledgeable regarding the area of the disputed issue. The mediator shall meet with the parties together or separately, as necessary, to review all aspects of the issue. In a final attempt to assist the parties in resolving the issue themselves prior to proceeding to arbitration the mediator shall provide, without prejudice, a non-binding recommendation for settlement.
- .04 The review by the mediator shall be completed within 90 Days following the opinion given in paragraph GC 3.13.03.05.
- .05 Each party is responsible for its own costs related to the use of the third party mediator process. The cost of the third party mediator shall be equally shared by the Owner and Contractor.

GC 3.13.06 Payment

- .01 Payment of the claim shall be made no later than 30 Days after the date of resolution of the claim or dispute. Such payment shall be made according to the terms of Section GC 8.0, Measurement and Payment.

GC 3.13.07 Rights of Both Parties

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

GC 3.14 Arbitration

GC 3.14.01 Conditions of Arbitration

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

- .02 Notification that arbitration shall be implemented to resolve the issue shall be communicated in writing as soon as possible and no later than 60 Days following the opinion given in paragraph GC 3.13.03.05. Where the use of a third party mediator was implemented, notification shall be within 120 Days of the opinion given in paragraph GC 3.13.03.05.
- .03 The parties shall be bound by the decision of the arbitrator.
- .04 The rules and procedures of the *Arbitration Act*, 1991, S.O. 1991, c.17, as amended, shall apply to any arbitration conducted hereunder except to the extent that they are modified by the express provisions of subsection GC 3.14, Arbitration.

GC 3.14.02 Arbitration Procedure

- .01 The following provisions are to be included in the agreement to arbitrate and are subject only to such right of appeal as exist where the arbitrator has exceeded his or her jurisdiction or have otherwise disqualified him or herself:
 - a) All existing actions in respect of the matters under arbitration shall be stayed pending arbitration;
 - b) All outstanding claims and matters to be settled are to be set out in a schedule to the agreement. Only such claims and matters as are in the schedule shall be arbitrated; and
 - c) Before proceeding with the arbitration, the Contractor shall confirm that all matters in dispute are set out in the schedule.

GC 3.14.03 Appointment of Arbitrator

- .01 The arbitrator shall be mutually agreed upon by the Owner and Contractor to adjudicate the dispute.
- .02 Where the Owner and Contractor cannot agree on a sole arbitrator within 30 Days of the notification of arbitration noted in paragraph GC 3.14.01.02, the Owner and the Contractor shall each choose an appointee within 37 Days of the notice of arbitration.
- .03 The appointees shall mutually agree upon an arbitrator to adjudicate the dispute within 15 Days after the last appointee was chosen or they shall refer the matter to the Arbitration and Mediation Institute of Ontario Inc., which may select an arbitrator to adjudicate the dispute within 7 Days of being requested to do so.
- .04 The arbitrator shall not be interested financially in the Contract nor in either party's business and shall not be employed by either party.
- .05 The arbitrator may appoint independent experts and any other persons to assist him or her.
- .06 The arbitrator is not bound by the rules of evidence that govern the trial of cases in court but may hear and consider any evidence that the arbitrator considers relevant.
- .07 The hearing shall commence within 90 Days of the appointment of the arbitrator.

GC 3.14.04 Costs

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

- .03 The arbitration hearing shall be held in a place mutually agreed upon by both parties or in the event the parties do not agree, a site shall be chosen by the arbitrator. The cost of obtaining appropriate facilities shall be shared equally by the Owner and the Contractor.
- .04 The arbitrator may, in his or her discretion, award reasonable costs, related to the arbitration.

GC 3.14.05 The Decision

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

GC 3.15 Archaeological Finds

- .01 If the Contractor's operations expose any items that may indicate an archaeological find, such as building remains, hardware, accumulations of bones, pottery, or arrowheads, the Contractor shall immediately notify the Contract Administrator and suspend operations within the area identified by the Contract Administrator. Notification may be verbal provided that such notice is confirmed in writing within 2 Days. Work shall remain suspended within that area until otherwise directed by the Contract Administrator in writing, in accordance with subsection GC 7.10, Suspension of Work.
- .02 Any delay in the completion of the Contract that is caused by such a suspension of Work shall be considered to be beyond the Contractor's control in accordance with paragraph GC 3.07.01.
- .03 Any work directed or authorized in connection with an archaeological find shall be considered as Extra Work in accordance with clause GC 3.10.02, Extra Work.
- .04 The Contractor shall take all reasonable action to minimize additional costs that may accrue as a result of any work stoppage.

SECTION GC 4.0 - OWNER'S RESPONSIBILITIES AND RIGHTS

GC 4.01 Working Area

- .01 The Owner shall acquire all property rights that are deemed necessary by the Owner for the construction of the Work, including temporary working easements, and shall indicate the full extent of the Working Area on the Contract Drawings.
- .02 The Geotechnical Report and Subsurface Report that may be provided by the Owner as part of the tender documents shall form part of the Contract Drawings.

GC 4.02 Approvals and Permits

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

GC 4.03 Management and Disposition of Materials

- .01 The Owner shall identify in the Contract Documents the materials to be moved within or removed from the Working Area and any characteristics of those materials that necessitates special materials management and disposition.
- .02 In accordance with regulations under the *Occupational Health and Safety Act*, R.S.O. 1990, c.O.1, as amended, the Owner advises that,
 - a) the designated substances silica, lead, and arsenic are generally present throughout the Working Area occurring naturally or as a result of vehicle emissions;
 - b) the designated substance asbestos may be present in cement products, asphalt, and conduits for Utilities;
 - c) the following hazardous materials are ordinarily present in construction activities: limestone, gypsum, marble, mica, and Portland cement; and
 - d) exposure to these substances may occur as a result of activities by the Contractor such as sweeping, grinding, crushing, drilling, blasting, cutting, and abrasive blasting.
- .03 The Owner shall identify in the Contract Documents any designated substances or hazardous materials other than those identified above and their location in the Working Area.
- .04 If the Owner or Contractor discovers or is advised of the presence of designated substances or hazardous materials that are in addition to those listed in paragraph GC 4.03.02, or not clearly identified in the Contract Documents according to paragraph GC 4.03.03, then verbal notice shall be provided to the other party immediately with written confirmation within 2 Days. The Contractor shall stop work in the area immediately and shall determine the necessary steps required to complete the work in accordance with applicable legislation and regulation.
- .05 The Owner shall be responsible for any reasonable additional costs of removing, managing and disposing of any material not identified in the Contract Documents, or where conditions exist that could not have been reasonably foreseen at the time of tendering. All work under this paragraph shall be deemed to be Extra Work.

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

GC 4.04 Construction Affecting Railway Property

- .01 The Owner shall pay the costs of all flagging and other traffic control measures required and provided by the railway company unless such costs are solely a function of the Contractor's chosen method of completing the Work.
- .02 Every precaution shall be taken by the Contractor to protect all railway property at track crossings; or otherwise, on which construction operations are to take place in accordance with the terms of this Contract.
- .03 The Contractor shall be required to conduct the construction operations in such a manner as to avoid a possibility of damaging any railway property in the vicinity of the works. Every reasonable precaution shall be taken by the Contractor to ensure the safety of the workers, Subcontractors, and Equipment, as well as railway property throughout the duration of the Contract.

GC 4.05 Default by the Contractor

- .01 If the Contractor fails to commence the Work within 14 Days of a formal order to commence work signed by the Contract Administrator or, upon commencement of the Work, should neglect to prosecute the Work properly or otherwise fails to comply with the requirements of the Contract and, if the Contract Administrator has given a written statement to the Owner and Contractor that sufficient cause exists to justify such action, the Owner may, without prejudice to any other right or remedy the Owner may have, notify the Contractor in writing that the Contractor is in default of the Contractor's contractual obligations and instruct the Contractor to correct the default in the 5 Working Days immediately following the receipt of such notice.
- .02 If the Contractor is adjudged bankrupt, or makes a general assignment for the benefit of creditors because of the Contractor's insolvency or if a receiver is appointed because of the Contractor's insolvency, the Owner may, without prejudice to any other right or remedy the Owner may have, by giving the Contractor or receiver or trustee in bankruptcy notice in writing, terminate the Contract.

GC 4.06 Contractor's Right to Correct a Default

- .01 The Contractor shall have the right within the 5 full Working Days following the receipt of a notice of default to correct the default and provide the Owner with satisfactory proof that appropriate corrective measures have been taken.
- .02 If the correction of the default cannot be completed within the 5 full Working Days following receipt of the notice, the Contractor shall not be in default if the Contractor,
- a) commences the correction of the default within the 5 full Working 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 in accordance with such schedule.

GC 4.07 Owner's Right to Correct Default

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

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

- .01 Where the Contractor fails to correct a default within the time specified in subsection GC 4.06, Contractor's Right to Correct a Default, or subsequently agreed upon, the Owner, without prejudice to any other right or remedy the Owner may have, may terminate the Contractor's right to continue the Work in whole or in part by giving written notice to the Contractor.
- .02 If the Owner terminates the Contractor's right to continue with the Work in whole or in part, the Owner shall be entitled to,
- a) take possession of the Working Area or that portion of the Working Area devoted to that part of the Work terminated;
 - b) use the Equipment of the Contractor and any Material within the Working Area that 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 7.16, Warranty;
 - f) charge the Contractor for any damages the Owner sustained as a result of the default; and
 - g) charge the Contractor the amount by which the cost of corrections to the Work under subsection GC 7.16, Warranty, exceeds the allowance provided for such corrections.

GC 4.09 Final Payment to Contractor

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

GC 4.10 Termination of the Contract

- .01 Where the Contractor is in default of the Contract the Owner 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 may provide the Contractor and the trustee or receiver with a complete accounting to the date of termination.

GC 4.11 Continuation of Contractor's Obligations

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

GC 4.12 Use of Performance Bond

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

GC 4.13 Payment Adjustment

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

SECTION GC 5.0 - MATERIAL

GC 5.01 Supply of Material

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

GC 5.02 Quality of Material

- .01 All Material supplied by the Contractor shall be new, unless otherwise specified in the Contract Documents.
- .02 Material supplied by the Contractor shall conform to the requirements of the Contract.
- .03 As specified in the Contract Documents or as requested by the Contract Administrator, the Contractor shall make available, for inspection or testing, a sample of any Material to be supplied by the Contractor.
- .04 The Contractor shall obtain for the Contract Administrator the right to enter onto the premises of the Material manufacturer or supplier to carry out such inspection, sampling, and testing as specified in the Contract Documents or as requested by the Contract Administrator.
- .05 The Contractor shall notify the Contract Administrator of the sources of supply sufficiently in advance of the Material shipping dates to enable the Contract Administrator to perform the required inspection, sampling, and testing.
- .06 The Owner shall not be responsible for any delays to the Contractor's operations where the Contractor fails to give sufficient advance notice to the Contract Administrator to enable the Contract Administrator to carry out the required inspection, sampling, and testing before the scheduled shipping date.
- .07 The Contractor shall not change the source of supply of any Material without the written authorization of the Contract Administrator.
- .08 Material that is not specified shall be of a quality best suited to the purpose required, and the use of such Material shall be subject to the approval of the Contract Administrator.
- .09 All Material inspection, sampling, and testing shall be carried out on random basis in accordance with the standard inspection or testing methods required for the Material. Any approval given by the Contract Administrator for the Materials to be used in the Work based upon the random method shall not relieve the Contractor from the responsibility of incorporating Material that conforms to the Contract Documents into the Work or properly performing the Contract and of any liability arising from the failure to properly perform as specified in the Contract Documents.

GC 5.03 Rejected Material

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

GC 5.04**Substitutions**

- .01 Where the Contract Documents require the Contractor to supply a Material designated by a trade or other name, the Tender shall be based only upon supply of the Material so designated, that shall be regarded as the standard of quality required by the Contract Documents. After the acceptance of the Tender, the Contractor may apply to the Contract Administrator to substitute another Material identified by a different trade or other name for the Material designated as aforesaid. The application shall be in writing and shall state the price for the proposed substitute Material designated as aforesaid, and such other information as the Contract Administrator may require.
- .02 Rulings on a proposed substitution shall not be made prior to the acceptance of the Tender. Substitutions shall not be made without the prior approval of the Contract Administrator. The approval or rejection of a proposed substitution shall be at the discretion of the Contract Administrator.
- .03 If the proposed substitution is approved by the Contract Administrator, the Contractor shall be entitled to the first \$1,000 of the aggregate saving in cost by reason of such substitution and to 50% of any additional saving in cost in excess of such \$1,000. Each such approval shall be conveyed to the Contractor in writing or by issuance of a Certificate of Equality on the Owner's standard form of "Certification of Equality" and, if any adjustment to the Contract price is made by reason of such substitution, a Change Order shall be issued as well.

GC 5.05**Owner Supplied Material****GC 5.05.01****Ordering of Excess Material**

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

GC 5.05.02**Care of Material**

- .01 The Contractor shall, in advance of receipt of shipments of Material supplied by the Owner, provide adequate and proper storage facilities acceptable to the Contract Administrator, and on the receipt of such Material shall promptly place it in storage, except where it is to be incorporated forthwith into the Work.
- .02 The Contractor shall be responsible for acceptance of Material supplied by the Owner, at the specified delivery point and for its safe handling and storage. If such Material is damaged while under the control of the Contractor, it shall be replaced or repaired by the Contractor at no expense to the Owner, and to the satisfaction of the Contract Administrator. If such Material is rejected by the Contract Administrator for reasons that are not the fault of the Contractor, it shall remain in the care and at the risk of the Contractor until its disposition has been determined by the Contract Administrator.
- .03 Where Material supplied by the Owner arrives at the delivery point in a damaged condition or where there are discrepancies between the quantities received and the quantities shown on the bills of lading, the Contractor shall immediately report such damage or discrepancies to the Contract Administrator who shall arrange for an immediate inspection of the shipment and provide the Contractor with a written release from responsibility for such damage or deficiencies. Where damage or deficiencies are not so reported, it shall be assumed that the shipment arrived in good condition and order, and any damage or deficiencies reported thereafter shall be made good by the Contractor at no extra cost to the Owner.

- .04 The full amount of Material supplied by the Owner in each shipment shall be accounted for by the Contractor and such Material shall be at the risk of the Contractor after taking delivery. Such Material shall not, except with the written permission of the Contract Administrator, be used by the Contractor for purposes other than the performance of the Work under the Contract.
- .05 Empty reels, crates, containers, and other type of packaging from Material supplied by the Owner shall become the property of the Contractor when they are no longer required for their original purpose and shall be disposed of by the Contractor, unless otherwise specified in the Contract Documents.
- .06 Immediately upon receipt of each shipment, the Contractor shall provide the Contract Administrator copies of bills of lading, or such other documentation the Contract Administrator may require to substantiate and reconcile the quantities of Material received.
- .07 Where Material supplied by the Owner is ordered and stockpiled prior to the award of the Contract, the Contractor shall, at no extra cost to the Owner, immediately upon commencement of operations, check the Material, report any damage or deficiencies to the Contract Administrator and take charge of the Material at the stockpile site. Where damage or deficiencies are not so recorded by the Contractor, it shall be assumed that the stockpile was in good condition and order when the Contractor took charge of it, and any damage or deficiencies reported thereafter shall be made good by the Contractor at no extra cost to the Owner.

SECTION GC 6.0 - INSURANCE, PROTECTION AND DAMAGE

GC 6.01 Protection of Work, Persons and Property

- .01 The Contractor, the Contractor's agents, and all workers employed by or under the control of the Contractor, including Subcontractors, shall protect the Work, persons, and property from damage or injury. The Contractor shall be responsible for all losses and damage that may arise as the result of the Contractor's operations under the Contract, unless indicated to the contrary below.
- .02 The Contractor is responsible for the full cost of any necessary temporary protective work or works and the restoration of all damage where the Contractor damages the Work or property in the performance of the Contract. If the Contractor is not responsible for the damage that occurs to the Work or property, the Contractor shall restore such damage, and such work and payment shall be administered according to these General Conditions.
- .03 The Contractor shall immediately inform the Contract Administrator of all damage and injuries that occur during the term of the Contract. The Contractor shall then investigate and report back to the Contract Administrator within 15 Days of occurrence of incident, or as soon as possible.
- .04 The Contractor shall not be responsible for loss and damage that occurs as a result of,
 - a) war;
 - b) blockades and civil commotions;
 - c) errors in the Contract Documents; or
 - d) acts or omissions of the Owner, the Contract Administrator, their agents and employees, or others not under the control of the Contractor, but within the Working Area with the Owner's permission.
- .05 The Contractor and the Contractor's Surety shall not be released from any term or provision of any responsibility, obligation, or liability under the Contract or waive or impair any of the rights of the Owner, except by a release duly executed by the Owner.

GC 6.02 Indemnification

- .01 The Contractor shall indemnify and hold harmless the Owner and the Contract Administrator, their elected officials, agents, officers, and employees from and against all claims, demands, losses, expenses, costs, damages, actions, suits, or proceedings by third parties, hereinafter called "claims", directly or indirectly arising or alleged to arise out of the performance of or the failure to perform the Work, provided such claims are,
 - a) attributable to bodily injury, sickness, disease, or death or to damage to or destruction of tangible property;
 - b) caused by negligent acts or omissions of the Contractor or anyone for whose acts the Contractor may be liable; and
 - c) made in writing within a period of 6 years from the date of Substantial Performance of the Work as set out in the Certificate of Substantial Performance of the Work or, where so specified in the Contract Documents, from the date of certification of Final Acceptance.

- .02 The Contractor shall indemnify and hold harmless the Owner from all and every claim for damages, royalties or fees for the infringement of any patented invention or copyright occasioned by the Contractor in connection with the Work performed or Material furnished by the Contractor under the Contract.
- .03 The Owner expressly waives the right to indemnity for claims other than those stated in paragraphs GC 6.02.01 and GC 6.02.02.
- .04 The Owner shall indemnify and hold harmless the Contractor, their elected officials, agents, officers, and employees from and against all claims, demands, losses, expenses, costs, damages, actions, suits, or proceedings arising out of the Contractor's performance of the Contract that are attributable to a lack of or defect in title or an alleged lack of or defect in title to the Working Area.
- .05 The Contractor expressly waives the right to indemnity for claims other than those stated in paragraph GC 6.02.04.

GC 6.03 Contractor's Insurance

GC 6.03.01 General

- .01 Without restricting the generality of subsection GC 6.02, Indemnification, the Contractor shall provide, maintain, and pay for the insurance coverages listed under clauses GC 6.03.02 and GC 6.03.03. Insurance coverage in clauses GC 6.03.04, GC 6.03.05, and GC 6.03.06 shall only apply when so specified in the Contract Documents.
- .02 The Contractor shall provide the Contract Administrator with an original Certificate of Insurance for each type of insurance coverage that is required by the Contract Documents. The Contractor shall ensure that the Contract Administrator is, at all times in receipt of a valid Certificate of Insurance for each type of insurance coverage, in such amounts as specified in the Contract Documents. The Contractor will not be permitted to commence work until the Contract Administrator is in receipt of such proof of insurance. The Contract Administrator may withhold payments of monies due to the Contractor until the Contractor has provided the Contract Administrator with original valid Certificates of Insurance as required by the provisions of the Contract Documents.

GC 6.03.02 General Liability Insurance

- .01 General liability insurance shall be in the name of the Contractor, with the Owner and the Contract Administrator named as additional insureds, with limits of not less than five million dollars inclusive per occurrence for bodily injury, death, and damage to property including loss of use thereof, with a property damage deductible of not more than \$5,000. The form of this insurance shall be the Insurance Bureau of Canada Form IBC 2100.
- .02 Another form of insurance equal to or better than that required in IBC Form 2100 may be used, provided all the requirements listed in the Contract are included. Approval of this insurance shall be conditional upon the Contractor obtaining the services of an insurer licensed to underwrite insurance in the Province of Ontario and obtaining the insurer's certificate of equivalency to the required insurance.
- .03 The Contractor shall maintain in force such policies of insurance specified by the Contract Documents at all times from the commencement of the Work until the end of any Warranty Period or as otherwise required by the Contract Documents.
- .04 The Contractor shall submit annually to the Owner, proof of continuation of the completed operations coverage and, if the Contractor fails to do so, the limitation period for claiming indemnity described in paragraph GC 6.02.01 c), shall not be binding on the Owner.

- .05 Should the Contractor decide not to employ Subcontractors for operations requiring the use of explosives for blasting, pile driving or caisson work, removal or weakening of support of property building or land, IBC Form 2100 as required shall include the appropriate endorsements.
- .06 The policies shall be endorsed to provide the Owner with not less than 30 Days written notice in advance of cancellation, change or amendment restricting coverage.
- .07 "Claims Made" insurance policies shall not be permitted.

GC 6.03.03 Automobile Liability Insurance

- .01 Automobile liability insurance in respect of licensed vehicles shall have limits of not less than five million dollars inclusive per occurrence for bodily injury, death and damage to property, in the following forms endorsed to provide the Owner with not less than 30 Days written notice in advance of any cancellation, change, or amendment restricting coverage:
 - a) standard non-owned automobile policy including standard contractual liability endorsement, and
 - b) standard owner's form automobile policy providing third party liability and accident benefits insurance and covering licensed vehicles owned or operated by the Contractor.

GC 6.03.04 Aircraft and Watercraft Liability Insurance

GC 6.03.04.01 Aircraft Liability Insurance

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

6.03.04.02 Watercraft Liability Insurance

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

GC 6.03.05 Property and Boiler Insurance

GC 6.03.05.01 Property Insurance

- .01 All risks property insurance shall be in the name of the Contractor, with the Owner and the Contract Administrator named as additional insureds, insuring not less than the sum of the amount of the Contract price and the full value, as may be stated in the Contract Documents, of Material that is specified to be provided by the Owner for incorporation into the Work, with a deductible not exceeding 1% of the amount insured at the site of the Work. This insurance shall be in a form acceptable to the Owner and shall be maintained continuously until 10 Days after the date of Final Acceptance of the Work, as set out in the Final Acceptance Certificate.

GC 6.03.05.02 Boiler Insurance

- .01 Boiler insurance insuring the interests of the Contractor, the Owner and the Contract Administrator for not less than the replacement value of boilers and pressure vessels forming part of the Work, shall be in a form acceptable to the Owner. This insurance shall be maintained continuously from commencement of use or operation of the property insured until 10 Days after the date of Final Acceptance of the Work, as set out in the Final Acceptance Certificate.

GC 6.03.05.03 Use and Occupancy of the Work Prior to Completion

- .01 Should the Owner wish to use or occupy part or all of the Work prior to Substantial Performance, the Owner shall give 30 Days written notice to the Contractor of the intended purpose and extent of such use or occupancy. Prior to such use or occupancy, the Contractor shall notify the Owner in writing of the additional premium cost, if any, to maintain property and boiler insurance, which shall be at the Owner's expense. If because of such use or occupancy the Contractor is unable to provide coverage, the Owner upon written notice from the Contractor and prior to such use or occupancy shall provide, maintain, and pay for property and boiler insurance insuring the full value of the Work, including coverage for such use or occupancy, and shall provide the Contractor with proof of such insurance. The Contractor shall refund to the Owner the unearned premiums applicable to the Contractor's policies upon termination of coverage.
- .02 The policies shall provide that, in the event of a loss or damage, payment shall be made to the Owner and the Contractor as their respective interests may appear. The Contractor shall act on behalf of both the Owner and the Contractor for the purpose of adjusting the amount of such loss or damage payment with the insurers. When the extent of the loss or damage is determined, the Contractor shall proceed to restore the Work. Loss or damage shall not affect the rights and obligations of either party under the Contract, except that the Contractor shall be entitled to such reasonable extension of Contract Time relative to the extent of the loss or damage as the Contract Administrator may decide in consultation with the Contractor.

GC 6.03.05.04 Payment for Loss or Damage

- .01 The Contractor shall be entitled to receive from the Owner, in addition to the amount due under the Contract, the amount at which the Owner's interest in restoration of the Work has been appraised, such amount to be paid as the restoration of the Work proceeds, and in accordance with the requirements of Section GC 8.0, Measurement and Payment. In addition, the Contractor shall be entitled to receive from the payments made by the insurers the amount of the Contractor's interest in the restoration of the Work.
- .02 The Contractor shall be responsible for deductible amounts under the policies, except where such amounts may be excluded from the Contractor's responsibility by the terms of this Contract.
- .03 In the event of a loss or damage to the Work arising from the action or omission of the Owner or others, the Owner shall pay the Contractor the cost of restoring the Work as the restoration of the Work proceeds and in accordance with the requirements of Section GC 8.0, Measurement and Payment.

GC 6.03.06 Contractor's Equipment Insurance

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

GC 6.03.07 Insurance Requirements and Duration

- .01 Unless specified otherwise, the duration of each insurance policy shall be from the date of commencement of the Work until 10 Days after the date of Final Acceptance of the Work, as set out in the Final Acceptance Certificate.
- .02 The Contractor shall provide the Owner, on a form acceptable to the Owner, proof of insurance prior to commencement of the Work and signed by an officer of the Contractor and either the underwriter or the broker.
- .03 The Contractor shall, on request, promptly provide the Owner with a certified true copy of each insurance policy exclusive of information pertaining to premium or premium bases used by the insurer to determine the cost of the insurance. The certified true copy shall include 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 Where a policy is renewed, the Contractor shall provide the Owner, on a form acceptable to the Owner, renewed proof of insurance immediately following completion of renewal.
- .05 Unless specified otherwise, the Contractor shall be responsible for the payment of deductible amounts under the policies.
- .06 If the Contractor fails to provide or maintain insurance as required in subsection GC 6.03, Contractor's Insurance, or elsewhere in the Contract Documents, then the Owner shall have the right to provide and maintain such insurance and give evidence thereof to the Contractor. The Owner's cost thereof shall be payable by the Contractor to the Owner on demand.
- .07 If the Contractor fails to pay the cost of the insurance placed by the Owner within 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 to the satisfaction of the Owner. The bonds shall be maintained in good standing until the fulfilment of the Contract.

GC 6.05**Workplace Safety and Insurance Board**

- .01 The Contractor shall provide the Contract Administrator with a copy of a Certificate of Clearance indicating the Contractor's good standing with the Workplace Safety and Insurance Board, as follows:
- a) Immediately prior to the Contract Administrator authorizing the Contractor to commence Work.
 - b) Prior to issue of the Certificate of Substantial Performance.
 - c) Prior to expiration of the Warranty Period.
 - d) At any other time when requested by the Contract Administrator.

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

GC 7.01

General

- .01 The Contractor warrants that the site of the Work has been visited during the preparation of the Tender and the character of the Work and all local conditions that may affect the performance of the Work are known.
- .02 The Contractor shall not commence the Work nor deliver anything to the Working Area until the Contractor has received a written order to commence the Work, signed by the Contract Administrator.
- .03 The Contractor shall have complete control of the Work and shall effectively direct and supervise the Work so as to ensure conformity with the Contract Documents. The Contractor shall be responsible for construction means, methods, techniques, sequences, and procedures and for coordinating the various parts of the Work.
- .04 The Contractor shall provide adequate labour, Equipment, and Material to ensure the completion of the Contract in accordance with the Contract Documents. The Work shall be performed as vigorously and as continuously as weather conditions or other interferences may permit.
- .05 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.
- .06 Notwithstanding paragraph GC 7.01.05, 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.
- .07 The Contractor shall execute the terms of the Contract in strict compliance with the requirements of the *Occupational Health and Safety Act*, R.S.O. 1990, c.O.1, as amended, (the "Act") and Ontario Regulation 213/91, as amended, (that regulates Construction Projects) and any other regulations as amended under the Act (the "Regulations") that may affect the performance of the Work, as the "Constructor" or "employer," as defined by the Act, as the case may be. The Contractor shall ensure that:
 - a) worker safety is given first priority in planning, pricing, and performing the Work;
 - b) its officers and supervisory employees have a working knowledge of the duties of a "Constructor" and "employer" as defined by the Act and the provisions of the Regulations applicable to the Work, and a personal commitment to comply with them;
 - c) a copy of the most current version of the Act and the Regulations are available at the Contractor's office within the Working Area, or, in the absence of an office, in the possession of the supervisor responsible for the performance of the Work;
 - d) workers employed to carry out the Work possess the knowledge, skills, and protective devices required by law or recommended for use by a recognized industry association to allow them to work in safety;
 - e) its supervisory employees 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 and their workers are properly protected from injury while they are at the Work Area.
- .08 The Contractor, when requested, shall provide the Owner with a copy of its health and safety policy and program at the pre-start meeting and shall respond promptly to requests from the Owner for confirmation that its methods and procedures for carrying out the Work comply with the Act and Regulations. The Contractor shall cooperate with representatives of the Owner and the inspectors appointed to enforce the Act and the Regulations in any investigations of worker health and safety in the performance of the Work. The Contractor shall indemnify and save the Owner harmless from any additional expense that the Owner may incur to have the Work performed as a result of the Contractor's failure to comply with the requirements of the Act and the Regulations.
- .09 Prior to commencement of the Work, the Contractor shall provide to the Contract Administrator a list of those products controlled under the Workplace Hazardous Materials Information System or WHMIS, which the Contractor expects to use on the Contract. Related Materials 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 in writing of changes in the products to be used and provide relevant Material Safety Data Sheets.
- .10 The Contractor shall have an authorized representative on the site while any Work is being performed, to supervise the Work and act for or on the Contractor's behalf. Prior to commencement of construction, the Contractor shall notify the Contract Administrator of the names; addresses; positions; and cell phone, pager, and telephone numbers of the Contractor's representatives who can be contacted at any time to deal with matters relating to the Contract, and update as necessary.
- .11 The Contractor shall designate a person to be responsible for traffic control and work zone safety. The designated person shall be a competent worker who is qualified because of knowledge, training, and experience to perform the duties; is familiar with Book 7 of the Ontario Traffic Manual; and has knowledge of all potential or actual danger to workers and motorists. Prior to the commencement of construction, the Contractor shall notify the Contract Administrator of the name; address; position; cell phone, pager, and telephone numbers of the designated person, and update as necessary. The designated person may have other responsibilities, including other construction sites, and need not be present in the Working Area at all times.
- .12 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.
- .13 The Contractor shall prepare and update, as required, a construction schedule of operations, indicating the proposed methods of construction and sequence of work and the time the Contractor proposes to complete the various items of work within the time specified in the Contract Documents. The schedule shall be submitted to the Contract Administrator within 14 Days from the Contract award. If the Contractor's schedule is materially affected by changes, the Contractor shall submit an updated construction schedule, if requested by the Contract Administrator, within 7 Days of the request. This updated schedule shall show how the Contractor proposes to perform the balance of the Work, so as to complete the Work within the time specified in the Contract Documents.
- .14 Where the Contractor finds any error, inconsistency, or omission relating to the Contract, the Contractor shall promptly report it to the Contract Administrator and shall not proceed with the activity affected until receiving direction from the Contract Administrator.
- .15 The Contractor shall promptly notify the Contract Administrator in writing if the subsurface conditions observed in the Working Area differ materially from those indicated in the Contract Documents.

- .16 The Contractor shall arrange with the appropriate Utility authorities for the stake out of all underground Utilities and service connections that may be affected by the Work. The Contractor shall observe the location of the stake outs prior to commencing the Work and in the event that there is a discrepancy between the location of the stake outs and the locations shown on the Contract Documents, that may affect the Work, the Contractor shall immediately notify the Contract Administrator and the affected Utility companies, in order to resolve the discrepancy. The Contractor shall be responsible for any damage done to the underground Utilities and service connections by the Contractor's forces during construction if the stake out locations are within the tolerances given in paragraph GC 2.01.01 a).

GC 7.02 Layout

- .01 Prior to commencement of construction, the Contract Administrator and the Contractor shall locate on site those property bars, baselines, and benchmarks that are necessary to delineate the Working Area and to lay out the Work, all 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 must be removed to facilitate the Work. Any other property bars disturbed, damaged, or removed by the Contractor's operations shall be replaced under the supervision of an Ontario Land Surveyor, at the Contractor's expense.
- .03 At no extra cost to the Owner, the Contractor shall provide the Contract Administrator with such materials and devices as may be necessary to lay out the baseline and benchmarks, and as may be necessary for the inspection of the Work.
- .04 The Contractor shall provide qualified personnel to lay out and establish all lines and grades necessary for construction. The Contractor shall notify the Contract Administrator of any layout work carried out, so that the same may be checked by the Contract Administrator.
- .05 The Contractor shall install and maintain substantial alignment markers and secondary benchmarks as may be required for the proper execution of the Work. The Contractor shall supply one copy of all alignment and grade sheets to the Contract Administrator.
- .06 The Contractor shall assume full responsibility for alignment, elevations, and dimensions of each and all parts of the Work, regardless of whether the Contractor's layout work has been checked by the Contract Administrator.
- .07 All stakes, marks, and reference points shall be carefully preserved by the Contractor. In the case of their destruction or removal, such stakes, marks, and reference points shall be replaced at the Contractor's expense.
- .08 Benchmarks and survey monuments identified in the Contract Documents shall be protected by the Contractor. In the case of their destruction or removal, such benchmarks and survey monuments shall be replaced by the Owner at the Contractor's expense.

GC 7.03 Working Area

- .01 The Contractor'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 the construction operations to the Working Area. 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 7.04 Damage by Vehicles or Other Equipment

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

GC 7.05 Excess Loading of Motor Vehicles

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

GC 7.06 Condition of the Working Area

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

GC 7.07 Maintaining Roads and Detours

- .01 Unless otherwise specified in the Contract Documents, if an existing Roadway is affected by construction, it shall be kept open to both vehicular and pedestrian traffic.
- .02 Subject to the approval of the Contract Administrator, the Contractor shall, at no additional cost to the Owner, be responsible for providing and maintaining for the duration of the Work an alternative route for both pedestrian and vehicular traffic through the Working Area in accordance with the OTM, whether along the existing Highway under construction or on a detour road beside or adjacent to the Highway under construction.
- .03 Subject to the approval of the Contract Administrator, the Contractor may block traffic for short periods of time to facilitate construction of the Work in accordance with the OTM. Any temporary lane closures shall be kept to a minimum.
- .04 The Contractor shall not be required to maintain a road through the Working Area until such time as the Contractor has commenced operations or during seasonal shut down or on any part of the Contract that has been accepted in accordance with these General Conditions. The Contractor shall not be required to apply de-icing chemicals or abrasives or carry out snowplowing.
- .05 Where localized and separated sections of the Highway are affected by the Contractor's operations, the Contractor shall not be required to maintain intervening sections of the Highway until such times as these sections are located within the limits of the Highway affected by the Contractor's general operations under the Contract.
- .06 Where the Contract Documents provide for or the Contract Administrator requires detours at specific locations, payment for the construction of the detours and, if required, for the subsequent removal of the detours, shall be made at the Contract prices appropriate to such work.

- .07 Compensation for all labour, Equipment, and Materials to do this Work shall be at the Contract prices appropriate to the Work and, where there are no such prices, at negotiated prices. Notwithstanding the foregoing, the cost of blading required to maintain the surface of such roads and detours shall be deemed to be included in the prices bid for the various tender items and no additional payment shall be made.
- .08 Where work under the Contract is discontinued for any extended period, including seasonal shutdown, the Contractor shall, when directed by the Contract Administrator, open and place the Roadway and detours in a passable, safe, and satisfactory condition for public travel.
- .09 Where the Contractor constructs a detour that is not specifically provided for in the Contract Documents or required by the Contract Administrator, the construction of the detour and, if required, the subsequent removal shall be performed at the Contractor's expense. The detour shall be constructed and maintained to structural and geometric standards approved by the Contract Administrator. Removal and site restoration shall be performed as directed by the Contract Administrator.
- .10 Where, with the prior written approval of the Contract Administrator, the Highway is closed and the traffic diverted entirely off the Highway to any other Highway, the Contractor shall, at no extra cost to the Owner, supply, erect, and maintain traffic control devices in accordance with the OTM.
- .11 Compliance with the foregoing provisions shall in no way relieve the Contractor of obligations under subsection GC 6.01, Protection of Work, Persons, and Property, dealing with the Contractor's responsibility for damage claims, except for claims arising on sections of Highway within the Working Area that are being maintained by others.

GC 7.08 Access to Properties Adjoining the Work and Interruption of Utility Services

- .01 The Contractor shall provide at all times and at no extra cost to the Owner,
 - a) adequate pedestrian and vehicular access; and
 - b) continuity of Utility servicesto properties adjoining the Working Area.
- .02 The Contractor shall provide at all times and at no extra cost to the Owner access to fire hydrants, water and gas valves, and all other Utilities located in the Working Area.
- .03 Where any interruptions in the supply of Utility services are required and are authorized by the Contract Administrator, the Contractor shall give the affected property owners notice in accordance with subsection GC 7.12, Notices by the Contractor, and shall arrange such interruptions so as to create a minimum of interference to those affected.

GC 7.09 Approvals and Permits

- .01 Except as specified in subsection GC 4.02, Approval and Permits, the Contractor shall obtain and pay for any permits, licences, and certificates, which at the date of tender closing, are required for the performance of the Work.
- .02 The Contractor shall arrange for all necessary inspections required by the approvals and permits specified in paragraph GC 7.09.01.

GC 7.10**Suspension of Work**

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

GC 7.11**Contractor's Right to Stop the Work or Terminate the Contract**

- .01 If the Owner is adjudged bankrupt or makes a general assignment for the benefit of creditors because of insolvency or if a receiver is appointed because of insolvency, the Contractor may, without prejudice to any other right or remedy the Contractor may have, by giving the Owner or receiver or trustee in bankruptcy written notice, terminate the Contract.
- .02 If the Work is stopped or otherwise delayed for a period of 30 Days or more under an order of a court or other public authority and provided that such order was not issued as the result of an act or fault of the Contractor or of anyone directly employed or engaged by the Contractor, the Contractor may, without prejudice to any other right or remedy the Contractor may have, by giving the Owner written notice, terminate the Contract.
- .03 The Contractor may notify the Owner in writing, with a copy to the Contract Administrator, that the Owner is in default of contractual obligations if,
- a) the Contract Administrator fails to issue certificates in accordance with the provisions of Section GC 8.0, Measurement and Payment;
 - b) the Owner fails to pay the Contractor, within 30 Days of the due dates identified in clause GC 8.02.03, Certification and Payment, the amounts certified by the Contract Administrator or within 30 Days of an award by an arbitrator or court; or
 - c) the Owner violates the requirements of the Contract.
- .04 The Contractor's written notice to the Owner shall advise that if the default is not corrected in the 7 Days immediately following receipt of the written notice, the Contractor may, without prejudice to any other right or remedy the Contractor may have, stop the Work or terminate the Contract.
- .05 If the Contractor terminates the Contract under the conditions set out in subsection GC 7.11, 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 7.12**Notices by the Contractor**

- .01 Before work is carried out that may affect the property or operations of any Ministry or agency of government or any person; company; partnership; or corporation, including a municipal corporation or any board or commission thereof, and in addition to such notices of the commencement of specified operations as are prescribed elsewhere in the Contract Documents, the Contractor shall give at least 48 hours advance written notice of the date of commencement of such work to the person, company, partnership, corporation, board, or commission so affected.
- .02 In the case of damage to or interference with any Utilities, pole lines, pipe lines, conduits, farm tiles, or other public or privately owned works or property, the Contractor shall immediately notify the Owner, Contract Administrator, and the owner of the works of the location and details of such damage or interference.

GC 7.13 Obstructions

- .01 Except as otherwise noted in these General Conditions, the Contractor assumes all the risks and responsibilities arising out of any obstruction encountered in the performance of the Work and any traffic conditions, including traffic conditions on any Highway or road giving access to the Working Area caused by such obstructions, and the Contractor shall not make any claim against the Owner for any loss, damage, or expense occasioned thereby.
- .02 Where the obstruction is an underground Utility or other man-made object, the Contractor shall not be required to assume the risks and responsibilities arising out of such obstruction, unless the location of the obstruction is shown on the Plans or described in the Contract Documents and the location so shown is within the tolerance specified in 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 in accordance with these General Conditions.
- .03 During the course of the Contract, it is the Contractor's responsibility to consult with Utility companies or other appropriate authorities for further information in regard to the exact location of these Utilities, to exercise the necessary care in construction operations, and to take such other precautions as are necessary to safeguard the Utilities from damage.

GC 7.14 Limitations of Operations

- .01 Except for such work as may be required by the Contract Administrator to maintain the Work in a safe and satisfactory condition, the Contractor shall not carry out operations under the Contract on Saturdays, Sundays, and Statutory Holidays without permission in writing from the Contract Administrator.
- .02 The Contractor shall cooperate and coordinate the Work with other Contractors, Utility companies, and the Owner and they shall be allowed access to their work or plant at all reasonable times.

GC 7.15 Cleaning Up Before Acceptance

- .01 Upon attaining Substantial Performance of the Work, the Contractor shall remove surplus materials, tools, construction machinery and equipment not required for the performance of the remaining Work. The Contractor shall also remove all temporary works and debris other than that caused by the Owner or others and leave the Work and Working Area clean and suitable for occupancy by the Owner, unless otherwise specified.
- .02 The Work shall not be deemed to have reached Completion until the Contractor has removed surplus materials, tools, construction machinery, and equipment. The Contractor shall also have removed debris, other than that caused by the Owner, or others.

GC 7.16 Warranty

- .01 Unless otherwise specified in the Contract Documents for certain Materials or components of the Work, the Contractor shall be responsible for the proper performance of the Work only to the extent that the design and standards permit such performance.
- .02 Subject to the previous paragraph the Contractor shall correct promptly, at no additional cost to the Owner, defects or deficiencies in the Work that appear,
 - a) prior to and during the period of 12 months from the date of Substantial Performance of the Work, as set out in the Certificate of Substantial Performance of the Work,

- b) where the work is completed after the date of Substantial Performance, 12 months after Completion of the Work,
- c) where there is no Certificate of Substantial Performance, 12 months from the date of Completion of the Work as set out in the Completion Certificate, or
- d) such longer periods as may be specified in the Contract Documents for certain Materials or some of the Work.

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

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

GC 7.17 Contractor's Workers

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

GC 7.18 Drainage

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

SECTION GC 8.0 - MEASUREMENT AND PAYMENT

GC 8.01 Measurement

GC 8.01.01 Quantities

- .01 The Contract Administrator shall make an Estimate once a month, in writing, of the quantity of Work performed. The first Estimate shall be the quantity of Work performed since the Contractor commenced the Contract, and every subsequent Estimate, except the final one, shall be of the quantity of Work performed since the preceding Estimate was made. The Contract Administrator shall provide the copy of each Estimate to the Contractor within 10 Days of the Cut-Off Date.
- .02 Such quantities for progress payments shall be construed and held to approximate. The final quantities for the issuance of the Completion Payment Certificate shall be based on the measurement of Work completed.
- .03 Measurement of the quantities of the Work performed may be either by Actual Measurement or by Plan Quantity principles as indicated in the Contract. Adjustments to Plan Quantity measurements shall normally be made using Plan Quantity principles but may, where appropriate, be made using Actual Measurements. Those items identified on the Tender by the notation (P) in the unit column shall be paid according to the Plan Quantity. Items where the notation (P) does not occur shall be paid according to Actual Measurement or lump sum.

GC 8.01.02 Variations in Tender Quantities

- .01 Where it appears that the quantity of Work to be done or Material to be supplied or both by the Contractor under a unit price tender item may exceed or be less than the tender quantity, the Contractor shall proceed to do the Work or supply the Material or both required to complete the tender item and payment shall be made for the actual amount of Work done or Material supplied or both at the unit prices stated in the Tender except as provided below:
 - a) In the case of a Major Item where the quantity of Work performed or Material supplied or both by the Contractor exceeds the tender quantity by more than 15%, either party to the Contract may make a written request to the other party to negotiate a revised unit price for that portion of the Work performed or Material supplied or both which exceeds 115% of the tender quantity. The negotiation shall be carried out as soon as reasonably possible. Any revision of the unit price shall be based on the actual cost of doing the Work or supplying the Material or both under the tender item plus a reasonable allowance for profit and applicable overhead.
 - b) In the case of a Major Item where the quantity of Work performed or Material supplied or both by the Contractor is less than 85% of the tender quantity, the Contractor may make a written request to negotiate for the portion of the actual overheads and fixed costs applicable to the amount of the underrun in excess of 15% of the tender quantity. For purposes of the negotiation, the overheads and fixed costs applicable to the item are deemed to have been prorated uniformly over 100% of the tender quantity for the item. Overhead costs shall be confirmed by a statement certified by the Contractor's senior financial officer or auditor and may be audited by the Owner. Alternatively, where both parties agree, an allowance equal to 10% of the unit price on the amount of the underrun in excess of 15% of the tender quantity shall be paid.

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

GC 8.02 Payment

GC 8.02.01 Price for Work

- .01 Prices for the Work shall be full compensation for all labour, Equipment and Material required in its performance. The term "all labour, Equipment, and Material" shall include Hand Tools, supplies, and other incidentals.
- .02 Payment for work not specifically detailed as part of any one item and without specified details of payment shall be deemed to be included in the items with which it is associated.

GC 8.02.02 Advance Payments for Material

- .01 The Owner shall make advance payments for Material intended for incorporation in the Work upon the written request of the Contractor and according to the following terms and conditions:
 - a) The Contractor shall deliver the Material to a site approved by the Contract Administrator and the Contractor shall, in advance of receipt of the shipment of the Material, arrange for adequate and proper storage facilities.
 - b) The value of aggregates, processed and stockpiled, shall be assessed by the following procedure:
 - i. Sources Other Than Commercial
 - (1) Granular A, B, BI, BII, BIII, M, and O shall be assessed at the rate of 60% of the Contract price.
 - (2) Coarse and fine aggregates for hot mix asphaltic concrete, surface treatment and Portland cement concrete shall be assessed at the rate of 25% of the Contract price for each aggregate stockpiled.
 - ii. Commercial Sources
 - Payment for separated coarse and fine aggregates shall be considered at the above rate when such materials are stockpiled at a commercial source where further processing is to be carried out before incorporating such materials into a final product. Advance payments for other materials located at a commercial source shall not be made.
 - c) Payment for all other materials, unless otherwise specified elsewhere in the Contract Documents, shall be based on the invoice price, and the Contractor shall submit proof of cost to the Contract Administrator before payment can be made by the Owner.
 - d) The payment for all Materials shall be prorated against the appropriate tender item by paying for sufficient units of the item to cover the value of the material. Such payment shall not exceed 80% of the Contract price for the item.
 - e) All Materials for which the Contractor wishes to receive advance payment shall be placed in the designated storage location immediately upon receipt of the material and shall thenceforth be held by the Contractor in trust for the Owner as collateral security for any monies advanced by the Owner and for the due completion of the Work. The Contractor shall not exercise any act of ownership inconsistent with such security, or remove any Material from the storage locations, except for inclusion in the Work, without the consent, in writing, of the Contract Administrator.
 - f) Such materials shall remain at the risk of the Contractor who shall be responsible for any loss, damage, theft, improper use, or destruction of the material however caused.
- .02 Where the Owner makes advance payments subject to the conditions listed in paragraph GC 8.02.02.01, such payment shall not constitute acceptance of the Material by the Owner. Acceptance shall only be determined when the material meets the requirements of the appropriate specification.

GC 8.02.03 Certification and Payment

GC 8.02.03.01 Progress Payment Certificate

- .01 The value of the Work performed and Material supplied shall be calculated once a month by the Contract Administrator in accordance with the Contract Documents and clause GC 8.01.01, Quantities.
- .02 The progress Payment Certificate shall show,
 - a) the quantities of Work performed;
 - b) the value of Work performed;
 - c) any advanced payment for Material;
 - d) the amount of statutory holdback, liens, Owner's set-off;
 - e) the amount of GST, as applicable; and
 - f) the amount due to the Contractor.
- .03 One copy of the progress Payment Certificate shall be sent to the Contractor.
- .04 Payment shall be made within 30 Days of the Cut-Off Date.

GC 8.02.03.02 Certification of Subcontract Completion

- .01 Before the Work has reached the stage of Substantial Performance, the Contractor may notify the Contract Administrator, in writing that a subcontract is completed satisfactorily and ask that the Contract Administrator certify the completion of such subcontract.
- .02 The Contract Administrator shall issue a Certificate of Subcontract Completion, if the subcontract has been completed satisfactorily, and all required inspection and testing of the works covered by the subcontract have been carried out and the results are satisfactory.
- .03 The Contract Administrator shall set out in the Certificate of Subcontract Completion the date on which the subcontract was completed and, within 7 Days of the date the subcontract is certified complete, the Contract Administrator shall give a copy of the certificate to the Contractor and to the Subcontractor concerned.

GC 8.02.03.03 Subcontract Statutory Holdback Release Certificate and Payment

- .01 Following receipt of the Certificate of Subcontract Completion, the Owner shall release and pay the Contractor the statutory holdback retained in respect of the subcontract. Such release shall be made 46 Days after the date the subcontract was certified complete and providing the Contractor submits the following to the Contract Administrator:
 - a) a document satisfactory to the Contract Administrator that shall release the Owner from all further claims relating to the subcontract, qualified by stated exceptions such as holdback monies;
 - b) evidence satisfactory to the Contract Administrator that the Subcontractor has discharged all liabilities incurred in carrying out the subcontract;

- c) a satisfactory clearance certificate or letter from the Workplace Safety and Insurance Board relating to the subcontract; and
 - d) a copy of the contract between the Contractor and the Subcontractor and a satisfactory statement showing the total amount due the Subcontractor from the Contractor.
- .02 Paragraph GC 8.02.03.03.01 d), shall only apply to Lump Sum Items and then only when the Contract Administrator specifically requests it.
- .03 Upon receipt of the statutory holdback, the Contractor shall forthwith give the Subcontractor the payment due under the subcontract.
- .04 Release of statutory holdback by the Owner in respect of a subcontract shall not relieve the Contractor, or the Contractor's Surety, of any of their responsibilities.

GC 8.02.03.04 Certification of Substantial Performance

- .01 Upon application by the Contractor and when the Contract Administrator has verified that the Contract has been substantially performed, the Contract Administrator shall issue a Certificate of Substantial Performance.
- .02 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 signing the said certificate, the Contract Administrator shall provide a copy to the Contractor.
- .03 Upon receipt of a copy of the Certificate of Substantial Performance, the Contractor shall forthwith, as required by Section 32(1) Paragraph 5 of the *Construction Lien Act*, R.S.O. 1990, c.C.30, as amended, publish a copy of the certificate in a construction trade newspaper. Such publication shall include placement in the Daily Commercial News.
- .04 Where the Contractor fails to publish a copy of the Certificate of Substantial Performance as required above within 7 Days after receiving a copy of the certificate signed by the Contract Administrator, the Owner may publish a copy of the certificate at the Contractor's expense.
- .05 Except as otherwise provided for in Section 31 of the *Construction Lien Act*, the 45 Day lien period prior to the release of holdback as referred to in clause GC 8.02.03.05, Substantial Performance Payment and Statutory Holdback Release Payment Certificates, shall commence from the date of publication of the Certificate of Substantial Performance as provided for above.

GC 8.02.03.05 Substantial Performance Payment and Substantial Performance Statutory Holdback Release Payment Certificates

- .01 When the Contract Administrator issues the Certificate of Substantial Performance, the Contract Administrator shall also issue the Substantial Performance Payment Certificate and the Substantial Performance Statutory Holdback Release Payment Certificate or where appropriate, a combined payment certificate.
- .02 The Substantial Performance Payment Certificate shall show,
- a) the value of Work performed to the date of Substantial Performance;
 - b) the value of outstanding or incomplete Work;
 - c) the amount of the statutory holdback, allowing for any previous releases of statutory holdback to the Contractor in respect of completed subcontracts and deliveries of pre-selected equipment;

- d) the amount of maintenance security required; and
 - e) the amount due the Contractor.
- .03 Payment of the amount certified shall be made within 30 Days of the date of issuance of the payment certificate.
- .04 The Substantial Performance Statutory Holdback Release Payment Certificate shall be a payment certificate releasing to the Contractor the statutory holdback due in respect of Work performed up to the date of Substantial Performance. Payment of such statutory holdback shall be due 46 Days after the date of publication of the Certificate of Substantial Performance but subject to the provisions of the *Construction Lien Act* and the submission by the Contractor of the following documents:
- a) a release by the Contractor in a form satisfactory to the Contract Administrator releasing the Owner from all further claims relating to the Contract, qualified by stated exceptions such as outstanding work or matters arising out of subsection GC 3.13, Claims, Negotiations, Mediation;
 - b) a statutory declaration in a form satisfactory to the Contract Administrator that all liabilities incurred by the Contractor and the Contractor's Subcontractors in carrying out the Contract have been discharged except for statutory holdbacks properly retained;
 - c) a satisfactory Certificate of Clearance from the Workplace Safety and Insurance Board; and
 - d) proof of publication of the Certificate of Substantial Performance.

GC 8.02.03.06 Certification of Completion

- .01 Upon application by the Contractor and when the Contract Administrator has verified that the Contract has reached Completion, the Contract Administrator shall issue a Completion Certificate.
- .02 The Contract Administrator shall set out in the Completion Certificate the date on which the Work was completed and, within 7 Days of signing the said certificate, the Contract Administrator shall provide a copy to the Contractor.

GC 8.02.03.07 Completion Payment and Completion Statutory Holdback Release Payment Certificates

- .01 When the Contract Administrator issues the Completion Certificate, the Contract Administrator shall also issue the Completion Payment Certificate and the Completion Statutory Holdback Release Payment Certificate or where appropriate, a combined payment certificate.
- .02 The Completion Payment Certificate shall show,
- a) measurement and value of Work at Completion;
 - b) the amount of the further statutory holdback based on the value of further work completed over and above the value of work completed shown in the Substantial Performance Payment Certificate referred to above; and
 - c) the amount due the Contractor.
- .03 The Completion Statutory Holdback Release Payment Certificate shall be a payment certificate releasing to the Contractor the further statutory holdback. Payment of such statutory holdback shall be due 46 Days after the date of Completion of the Work as established by the Completion Certificate but subject to the provisions of the *Construction Lien Act* and the submission by the Contractor of the following documents:

- a) a release by the Contractor in a form satisfactory to the Contract Administrator releasing the Owner from all further claims relating to the Contract, qualified by stated exceptions where appropriate;
- b) a statutory declaration in a form satisfactory to the Contract Administrator that all liabilities incurred by the Contractor and the Contractor's Subcontractors in carrying out the Contract have been discharged, qualified by stated exceptions where appropriate; and
- c) a satisfactory Certificate of Clearance from the Workplace Safety and Insurance Board.

GC 8.02.03.08 Interest

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

GC 8.02.03.09 Interest for Late Payment

- .01 Provided the Contractor has complied with the requirements of the Contract, including all documentation requirements, when payment by the Owner to the Contractor for Work performed, or for release of statutory holdback, is delayed by the Owner, then the Contractor shall be entitled to receive interest on the outstanding payment at the Rate of Interest, if payment is not received on the dates set out below:
 - a) Progress Payment Certificates: 30 Days after the Cut-Off Date;
 - b) Certificate of Subcontract Completion: 30 Days after the date certified as the date on which the subcontract was completed;
 - c) Subcontract Statutory Holdback Release Payment Certificate: 76 Days after the date on which the subcontract was completed;
 - d) Substantial Performance Payment Certificate: 30 Days after the date of issuance of the certificate;
 - e) Substantial Performance Statutory Holdback Release Payment Certificate: 76 Days after publication of the Payment Certificate of Substantial Performance;
 - f) Completion Payment Certificate: 30 Days after the date certified as the date on which the Contract reached Completion; and
 - g) Completion Statutory Holdback Release Payment Certificate: 76 Days after the date certified as the date that the Work was completed.
- .02 If the Contractor has not complied with the requirements of the Contract, including all documentation requirements, prior to expiration of the time periods described in paragraph GC 8.02.03.09.01, interest shall only begin to accrue when the Contractor has completed those requirements.

GC 8.02.03.10 Interest for Negotiations and Claims

- .01 Except as hereinafter provided, where a notice of negotiation, notice of intent to claim and the subsequent claims are submitted in accordance with the time limits or procedure or both described by subsection GC 3.13, Claims, Negotiations, Mediation, the Owner shall pay the Contractor the Rate of Interest on the amount of the negotiated price for that part of the Work or on the amount of the settled claim. Such interest shall not commence until 30 Days after the satisfactory completion of that part of the Work.
- .02 Where the Contractor does not attempt to resolve the negotiation or the claim in an expeditious manner, interest shall be negotiable.
- .03 Where the Contractor fails to give notice of a claim within the time limit prescribed by subsection GC 3.13, Claims, Negotiations, Mediation, interest shall not be paid.
- .04 Where a Contractor fails to comply with the 30 Day time limit and the procedures prescribed in paragraph GC 3.13.03.03 for submission of claims, interest shall not be paid for the delay period.

GC 8.02.03.11 Owner's Set-Off

- .01 Pursuant to Section 12 of the *Construction Lien Act*, the Owner may retain from monies owing to the Contractor under this Contract an amount sufficient to cover any outstanding or disputed liabilities, including the cost to remedy deficiencies, the reduction in value of substandard portions of the Work, claims for damages by third parties that have not been determined in writing by the Contractor's insurer, undetermined claims by the Owner under paragraph GC 8.01.02.01 a), any assessment due the Workplace Safety and Insurance Board, and any monies to be paid to the workers in accordance with clause GC 8.02.06, Payment of Workers.
- .02 Under these circumstances the Owner will give the Contractor appropriate notice of such action.

GC 8.02.03.12 Delay in Payment

- .01 The Owner shall not be deemed to be in default of the Contract provided any delay in payment does not exceed 30 Days from the due dates as defined in paragraph GC 8.02.03.09.01.

GC 8.02.04 Payment on a Time and Material Basis

GC 8.02.04.01 Definitions

- .01 For the purpose of clause GC 8.02.04 the following definitions apply:

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

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

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

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

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

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

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

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

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

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

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

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

GC 8.02.04.02 Daily Work Records

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

GC 8.02.04.03 Payment for Work

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

GC 8.02.04.04 Payment for Labour

- .01 The Owner shall pay the Contractor for labour employed on each Time and Material project at 135% of the Cost of Labour up to \$3,000, then at 120% of any portion of the Cost of Labour in excess of \$3,000.
- .02 The Owner shall make payment in respect of Payroll Burden for Work on a Time and Material Basis at the Contractor's actual cost of Payroll Burden.
- .03 At the Owner's discretion, an audit may be conducted in which case the actual Payroll Burden so determined shall be applied to all Time and Material work on the Contract.

GC 8.02.04.05 Payment for Material

- .01 The Owner shall pay the Contractor for Material used on each Time and Material project at 120% of the Cost of the Material up to \$3,000, then at 115% of any portion of the Cost of Material in excess of \$3,000.

GC 8.02.04.06 Payment for Equipment

GC 8.02.04.06.01 Working Time

- .01 The Owner shall pay the Contractor for the Working Time of all Equipment, other than Rented Equipment and Operated Rented Equipment, used on the Work on a Time and Material basis at The 127 Rates with a cost adjustment as follows:
- a) Cost \$10,000 or less - no adjustment;
 - b) Cost greater than \$10,000 but not exceeding \$20,000 - payment \$10,000 plus 90% of the portion in excess of \$10,000; and
 - c) Cost greater than \$ 20,000 - \$19,000 plus 80% of the portion in excess of \$20,000.
- .02 The Owner shall pay the Contractor for the Working Time of Rented Equipment used on the Work on a Time and Material Basis at 110% of the invoice price approved by the Contract Administrator up to a maximum of 110% of The 127 Rate. This constraint shall be waived when the Contract Administrator approves the invoice price prior to the use of the Rented Equipment.
- .03 The Owner shall pay the Contractor for the Working Time of Operated Rented Equipment used on the Work on a Time and Material Basis at 110% of the Operated Rented Equipment invoice price approved by the Contract Administrator prior to the use of the Equipment on the Work on a Time and Material Basis.

GC 8.02.04.06.02 Standby Time

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

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

- .02 In addition, the Owner shall include the Cost of Labour of operators or associated labourers who cannot be otherwise employed during the standby period or during the period of idleness caused by the circumstances giving rise to the Work on a Time and Material Basis.
- .03 The Contract Administrator may require Rented Equipment idled by the circumstances giving rise to the Work on Time and Material Basis to be returned to the lessor until the work requiring the equipment can be resumed. The Owner shall pay such costs as a result from such return.
- .04 When Equipment is transported, solely for the purpose of the Work on a Time and Material Basis, to or from the Working Area on a Time and Material basis, payment shall be made by the Owner only in respect of the transporting units. When Equipment is moved under its own power it shall be deemed to be working. The method of moving Equipment and the rates shall be subject to the approval of the Contract Administrator.

GC 8.02.04.07 Payment for Hand Tools

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

GC 8.02.04.08 Payment for Work By Subcontractors

- .01 Where the Contractor arranges for Work on a Time and Material Basis, or a part of it, to be performed by Subcontractors on a Time and Material basis and has received approval prior to the commencement of such work, in accordance with the requirements of subsection GC 3.09, Subcontracting by the Contractor, the Owner shall pay the cost of Work on a Time and Material Basis by the Subcontractor calculated as if the Contractor had done the Work on a Time and Material Basis, plus a markup calculated on the following basis:
 - a) 20% of the first \$3,000; plus
 - b) 15% of the amount from \$3,000 to \$10,000; plus
 - c) 5% of the amount in excess of \$10,000.
- .02 No further markup shall be applied regardless of the extent to which the work is assigned or sublet to others. If work is assigned or sublet to an associate, as defined by the *Securities Act*, no markup whatsoever shall be applied.

GC 8.02.04.09 Submission of Invoices

- .01 At the start of the Work on a Time and Material Basis, the Contractor shall provide the applicable labour and Equipment rates not already submitted to the Contract Administrator during the course of such work.
- .02 Separate summaries shall be completed by the Contractor according to the standard form "Summary for Payment of Accounts on a Time and Material Basis." Each summary shall include the Change Directive or Change Order number and covering dates of the work and shall itemize separately the labour, Materials, and Equipment. Invoices for Materials, Rented Equipment, and other charges incurred by the Contractor on the Work on a Time and Material Basis shall be included with each summary.

- .03 Each month the Contract Administrator shall include with the monthly progress payment certificate, the costs of the Work on a Time and Material Basis incurred during the preceding month all in accordance with the contract administrative procedures and the Contractor's invoice of the Work on a Time and Material Basis.
- .04 The final "Summary for Payment of Accounts on a Time and Material Basis" shall be submitted by the Contractor within 60 Days after the completion of the Work on a Time and Material Basis.

GC 8.02.04.10 Payment Other Than on a Time and Material Basis

- .01 Clause GC 8.02.04 does not preclude the option of the Contract Administrator and the Contractor negotiating a Lump Sum Item or unit price payment for Change in the Work, Extra Work, and Additional Work.

GC 8.02.04.11 Payment Inclusions

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

GC 8.02.05 Final Acceptance Certificate

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

GC 8.02.06 Payment of Workers

- .01 The Contractor shall, in addition to any fringe benefits, pay the workers employed on the Work in accordance with the labour conditions set out in the Contract and at intervals of not less than twice a month.
- .02 The Contractor shall require each Subcontractor doing any part of the Work to pay the workers employed by the Subcontractor on the Work in accordance with paragraph GC 8.02.06.01.
- .03 Where any person employed by the Contractor or any Subcontractor or other person on the Work is paid less than the amount required to be paid under the Contract, the Owner may set off monies in accordance with clause GC 8.02.03.11, Owner's Set-Off.

GC 8.02.07 Records

- .01 The Contractor shall maintain and keep accurate Records relating to the Work, Changes in the Work, Extra Work, and claims arising therefrom. Such Records shall be of sufficient detail to support the total cost of the Work, Changes in the Work, and Extra Work. The Contractor shall preserve all such original Records until 12 months after the Final Acceptance Certificate is issued or until all claims have been settled, whichever is longer. The Contractor shall require that Subcontractors employed by the Contractor preserve all original Records pertaining to the Work, Changes in the Work, Extra Work, and claims arising therefrom for a similar period of time.
- .02 The Owner may inspect and audit the Contractor's Records relating to the Work, Extra Work, and Changes in the Work at any time during the period of the Contract. The Contractor shall supply certified copies of any part of its Records required, whenever requested by the Owner.

GC 8.02.08**Taxes**

- .01 Where a change in Canadian Federal or Provincial taxes occurs after the date of tender closing for this Contract, and this change could not have been anticipated at the time of 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 forms provided by the Contract Administrator to the Contractor. Such claims for additional tax costs shall be submitted not less than 30 Days after the date of Final Acceptance.
- .03 Where the Contractor benefits from a change in Canadian Federal or Provincial taxes, the Contractor shall submit to the Contract Administrator, on forms provided by the Contract Administrator, a statement of such benefits. This statement shall be submitted not later than 30 Days after Final Acceptance.
- .04 Changes in Canadian Federal or Provincial taxes that impact upon commodities, which when left in place form part of the finished Work, or the provision of services, where such services form part of the Work and where the manufacture or supply of such commodities or the provision of such services is carried out by the Contractor or a Subcontractor, are subject to a claim or benefit as detailed above. Services in the latter context means the supply and operation of equipment, the provision of labour, and the supply of commodities that do not form part of the Work.

GC 8.02.09**Liquidated Damages**

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



NOTICE TO USERS OF OPSS.MUNI 106

GENERAL SPECIFICATION FOR ELECTRICAL WORK

OPSS.MUNI 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

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120.01 SCOPE

This specification covers the requirements for the use of explosives.

120.01.01 Specification Significance and Use

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

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

120.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

120.02 REFERENCES

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

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

Ontario Ministry of Transportation Publications

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

Department of Fisheries and Oceans (DFO) Publication

Guidelines for the Use of Explosives in or Near Canadian Fisheries Waters, 1998

International Society of Explosives Engineers (ISEE)

Performance Specifications for Blasting Seismographs, 2011 Edition

120.03 DEFINITIONS

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

Blaster means a competent person knowledgeable, experienced, and trained in the handling, use, and storage of explosives and their effect on adjacent property and persons.

Blast Monitoring Consultant means a consulting engineering firm with a minimum of 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.

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

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 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 75 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 250 m of the right-of-way in the vicinity of the blast. The notice shall include a blasting schedule, information about the audible blast warning system, and contact name for questions or other concerns.

The Contractor shall ensure that a competent person is available to receive, document, and deal with public inquiries before and after blasting operations.

A minimum 48 hours prior to blasting, sufficient detail regarding the blasting operations shall be provided to NAV Canada.

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 250 m from the blast or at the closest portion of any residence, Utility, 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.

120.07.07**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

This specification should be included on all projects that require the use of explosives.

The designer should determine if Utility authorities have any special measures or minimum offset distances and include them in the Contract Documents.

The designer should identify if there are site-specific conditions or environmental issues that may affect blasting design and alter monitoring requirements, pre-blast survey limits, pre-blast survey requirements, or notification limits as necessary, and include them in the Contract Documents.

The designer should provide names of Utility authorities and contacts involved in the Contract.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.



GENERAL SPECIFICATION FOR THE MANAGEMENT OF EXCESS MATERIALS

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180.01 SCOPE

This specification covers requirements for the management of excess materials.

Where the management of excess material requirements of other Ontario Provincial Standard Specifications differs from this specification, the requirements of this specification will take precedence.

180.01.01 Specification Significance and Use

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

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

180.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

180.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 206 Grading
OPSS 209 Swamp Excavation

Ontario Provincial Standard Specification, Material

OPSS 1004 Aggregates - Miscellaneous

Canadian and Provincial Statutes

Environmental Protection Act, R.S.O. 1990, c.E.19
& R.R.O. 1990, Regulation 347
GENERAL - WASTE MANAGEMENT
As amended

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

Fire Protection and Prevention Act, 1997
S.O. 1997, CHAPTER 4

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

Bituminous Pavement means any combination of asphaltic material and aggregate, excluding asbestos modified asphaltic material.

Commercial Waste means waste described as commercial waste in Regulation 347, under the Environmental Protection Act, Ontario.

Concrete means concrete mixtures produced with Portland cement and may include blended hydraulic cement, supplementary cement materials, spent debris and silica sand abrasive blasting media from abrasive cleaning of concrete and reinforcing steel, and concrete brick and block and associated mortar. It may include embedded steel and excludes asbestos modified Portland cement concrete mixtures.

Disposable Fill means excess material other than that disposed of at a certified disposal site and that is managed in berms and mounds and as fill other than in road embankments.

Earth means earth as defined in OPSS 206.

Excess Material means material removed under the Work specified in the Contract Documents for which management is not specified and includes surplus and unsuitable materials.

Fabricated Metal and Plastic Products means metal and plastic products such as culverts, fence materials, and guide rails. It does not include containers, other packaging materials, storage tanks, septic tanks and ancillary equipment associated with sanitary sewage systems, septic systems, and fuel or lubricant dispensing and storage systems.

Groundwater means subsurface water and water that occurs beneath the water table in soils and rock formations that are fully saturated.

Manufactured Wood means wood that is not entirely natural wood.

Masonry means clay brick and associated mortar.

Natural Wood means stumps, trunks, branches, debris from tree and shrub removal, and wood products that are not treated, coated, or glued.

Non-Hazardous Solid Industrial Waste means waste described as non-hazardous solid waste in Regulation 347, under the Environmental Protection Act, Ontario.

Re-Use means using, processing, re-processing, or recycling of excess material into a construction material or other useful product and managed by these means for the Contract and other work.

Rock means rock as defined in OPSS 206.

Subject Waste means waste defined as subject waste in Regulation 347, under the Environmental Protection Act, Ontario.

Swamp Material means swamp material as defined in OPSS 209.

Waste means excess material that is not managed by re-use, open burning, or as disposable fill and includes any excess material.

Waterbody means waterbody as defined in OPSS 182.

180.04 DESIGN AND SUBMISSION REQUIREMENTS

180.04.01 Submission Requirements

180.04.01.01 Notification of Site Selection, and Property Owner Release

A copy of the completed form OPSF 180-1, Site Selection Notification for Stockpiling Materials Managed Through Re-Use, or OPSF 180-2, Site Selection Notification for Material Managed as Disposable Fill or both shall be submitted to the Contract Administrator and the property owner at least two weeks prior to the use of the property. These forms are not required for property owned by the Owner or designated for use in the Contract Documents.

At the completion of such work, a completed copy of the form OPSF 180-3, Property Owner's Release, shall be provided to the Contract Administrator.

180.04.01.02 Verification of Management by Disposal as Non-Hazardous Solid Industrial or Commercial Waste

When excess material is managed by disposal as non-hazardous solid industrial or commercial waste, a copy of the weigh ticket or receipt provided by the disposal site operator shall be submitted to the Contract Administrator on a weekly basis. When such documentation is not available, written confirmation that the waste has been received shall be obtained from the operator of the disposal site and provided to the Contract Administrator within two weeks after disposal activities are complete.

Within three weeks of the completion of all disposal activities associated with the work, a completed copy of the form OPSF 180-5, Waste Quantity Report, shall be provided to the Contract Administrator and shall account for all excess material managed by disposal as solid non-hazardous industrial or commercial waste.

180.04.01.03 Notification of Forest Resource Licensees

Forest Resource licensees identified in the Contract Documents shall be notified at least two weeks prior to commencement of open burning.

180.04.01.04 Environmental Compliance Approval

When Environmental Compliance Approval(s)/Certificates of Approval for a Waste Management System or a Waste Disposal Site are required, a copy of such approval shall be supplied to the Contract Administrator prior to transporting excess material or waste from the Working Area.

180.04.01.05 Subject Waste Documentation

For each subject waste listed in the form OPSF 180-4, Subject Waste Classification, that is being shipped from the Working Area to a waste disposal site, the following shall be completed:

- a) The Contract Administrator shall be notified at least two weeks prior to the first shipment of subject waste, and at least 24 hours prior to each subsequent shipment of subject waste.
- b) A Regulation 347 manifest with Part B completed by the carrier for each truckload of subject waste, shall be submitted to the Contract Administrator for Part A completion. Copies #1 and #2 of the manifest with Part A and B completed shall be retained by the Contract Administrator and the remaining copies #3 to #6 returned to the carrier.
- c) Copy #6 of the Regulation 347 manifest shall be forwarded to the Contract Administrator at the mailing address indicated on Part A of the manifest, within four weeks of the shipment of subject waste from the Working Area.

For each subject waste that is generated by the Contractor's operations and that is not listed in form OPSF 180-4, Subject Waste Classification that is being shipped from the Working Area to a waste disposal site, the following documentation shall be provided to the Contract Administrator.

a) Prior to shipment of the subject waste:

- i. Test results from testing to determine the Regulation 347 waste class and characteristics of the subject waste from the Canadian Association for Laboratory Accreditation (CALA) accredited laboratory selected by the Contractor;
- ii. Notification from the Ministry of the Environment and Climate Change(MOECC) Hazardous Waste Information Network (HWIN) of the registration of the subject waste to obtain a Regulation 347 Generator Registration Number (GRN); and
- iii. A duplicate of Copy #2 of the Regulation 347 manifest with Parts A and B completed and signed by the generator and carrier respectively.

b) After shipment of the subject waste:

- i. Notification of payment of all registration, manifest, and tonnage fees associated with the shipment from the MOECC HWIN;
- ii. A duplicate of Copy #6 of the Regulation 347 manifest with Part C completed and signed by the receiver; and
- iii. Notification of de-activation of the Regulation 347 GRN in the MOECC HWIN.

A record of all test sample numbers and sample dates shall be kept and made available to the Contract Administrator upon request.

180.04.01.06 Excess Material Audit or Inventory Document

When an excess material audit or inventory is imposed by statute or is a condition specified in the Contract Documents, a copy of the audit or inventory documents shall be provided to the Contract Administrator.

180.04.01.07 Alternative Management Condition Approvals

When certain excess material is to be managed according to the conditions approved in writing by the local District office of the Ministry of Environment and Climate Change of Ontario and such conditions differ from those specified in Table A, a copy of such approval shall be provided to the Contract Administrator at least two weeks prior to commencement of the work governed by the condition.

180.07 CONSTRUCTION

180.07.01 Conditions on Management of Excess Material - General

Management of excess material shall be as described in Tables A and B and the appropriate subsections of this specification, unless prior alternative management conditions are approved in writing by the Ministry of Environment of Ontario and Climate Change (MOECC).

When an excess material is a mixture of materials, it shall be managed in compliance with the most stringent conditions associated with any of the constituent excess material.

When excess material includes asbestos waste, the asbestos waste shall be managed as specified in the Contract Documents.

Excess materials shall not be permitted in waterbodies and sensitive areas as identified in the Contract Documents, except when re-used according to the appropriate Ontario Provincial Standard.

180.07.02 Conditions on Management by Re-Use

Management of excess material by re-use for incorporation into the work or for other designated re-use shall be as specified in the Contract Documents.

Management by re-use shall otherwise be outside the Owner's property.

Distance separations described in Table B do not apply for the following:

- a) Re-use of excess materials for the same purpose.
- b) Re-use of bituminous pavement, concrete, and masonry within a road right-of-way.
- c) Re-use of concrete as aggregate in bituminous pavement.
- d) Re-use of concrete as rip-rap, gabion stone, or rock protection in compliance with the requirements of OPSS 1004.

Except cutting for construction purposes, excess material consisting of manufactured wood shall not be reprocessed.

180.07.03 Conditions on Management as Disposable Fill

Management of excess material as disposable fill, including sidecasting of swamp material, within the Owner's property and on other property designated in the Contract Documents shall be as specified in the Contract Documents.

Natural wood and debris from open fires may be managed as disposable fill only within a road right-of-way or on property with a boundary common to a road right-of-way, both within the Contract limits.

Such material shall be top covered by at least 300 mm of earth or topsoil.

180.07.04 Conditions on Management by Open Burning

Management of excess material by open burning is permitted only when specified in the Contract Documents. Where management by open burning is permitted, it shall be subject to the following conditions and conducted in accordance with the Fire Protection and Prevention Act, 1997 where it applies, and with any applicable, local, municipal by-law(s):

- a) A permit from the Ministry of Natural Resources and Forestry (MNRF) under the Fire Protection and Prevention Act, and/or applicable local or municipal by-law shall be obtained by the Contractor for open burning, as required.
- b) Open burning is prohibited in areas subject to a restricted fire zone order as issued by MNRF or to a smog alert advisory as issued by MOECC.

180.07.05 Conditions on Management by Disposal as Non-Hazardous Solid Industrial or Commercial Waste

Management of excess material by disposal as non-hazardous solid industrial or commercial waste at receiving sites designated in the Contract Documents shall be as specified in the Contract Documents.

When receiving sites are not specified in the Contract Documents for management by disposal as non-hazardous solid industrial or commercial waste, such material shall be disposed of at sites identified by the Contractor.

Non-hazardous solid industrial or commercial waste shall be transported from the Working Area directly to a site that has an Environmental Compliance Approval/ Certificate of Approval for a Waste Disposal Site that is valid for non-hazardous solid industrial or commercial waste.

180.07.06 Conditions on Management by Stockpiling

Management of excess material by stockpiling within the Owner's property and on other property designated in the Contract Documents shall be as specified in the Contract Documents.

Stockpiling shall otherwise be outside the Owner's property.

Stockpiles of bituminous pavement, concrete, and masonry shall be separated according to Table B unless either of the following occurs:

- a) Stockpiles are located within a road right-of-way or on property with a boundary common to a right-of-way, both within the Contract limits for a period not exceeding 120 Days.
- b) Stockpiles are located within a provincial or municipal works yard or in a commercially licensed pit or quarry.

For all other excess materials, where Table A indicates that stockpiling is subject to management conditions in Table B, such management conditions only apply to stockpiles that are to be in place for a period exceeding 120 Days.

180.07.07 Conditions on Management by Disposal as Subject Waste

When an excess material is identified as a dangerous good waste or a subject waste in form OPSF 180-4, Subject Waste Classification, management shall be as follows:

- a) Subject waste shipments shall be manifested and transported directly to a certified waste disposal site.
- b) When the subject waste is also a dangerous good as described in the Transportation of Dangerous Goods Act (TDGA), the carrier shall provide all necessary TDGA labels and placards.

When an excess material generated by the Contractor's operations may be subject waste and it is not identified in form OPSF 180-4, Subject Waste Classification, the Contractor shall be responsible to manage it in accordance with the following:

- a) Conduct sampling and testing using a laboratory certified by the Canadian Association of Laboratory Accreditation (CALA) selected by the Contractor to determine whether it is subject waste and to determine the Regulation 347 waste class and characteristics.
- b) Register all subject waste in the MOECC HWIN and obtain a Regulation 347 GRN for disposal.
- c) Package and label all subject waste for transportation and disposal.
- d) Arrange for shipment of all subject waste to a certified waste disposal site using a certified carrier.
- e) Complete Part A of a Regulation 347 manifest including the GRN obtained from the MOECC HWIN and provide the manifest to the certified carrier for completion of Part B.
- f) Provide a duplicate of Copy #2 of the Regulation 347 manifest to the Contract Administrator with Parts A and B completed and signed.
- g) Pay all registration, manifest and tonnage fees associated with subject waste disposal in the MOECC HWIN.

- h) De-activate the GRN in the MOECC HWIN after shipment of all subject waste to a certified waste disposal site is complete and acceptance of the subject waste is acknowledged by the receiver completing and signing Part C of the Regulation 347 manifest.
- i) Provide a duplicate of Copy #6 of the Regulation 347 manifest to the Contract Administrator upon receipt from the receiver.

When an excess material is tested and found not to be a dangerous good waste or a subject waste, it shall be managed by disposal as Non-Hazardous Solid Industrial or Commercial Waste in accordance with this specification.

180.10 BASIS OF PAYMENT

Payment for the management of excess material shall be included in the tender items requiring such management and shall include all costs associated with acquiring approvals, releases, and agreements.

Payment for the management of excess material that is subject waste generated by the Contractor's operations and not listed in form OPSF 180-4 by the Owner, and is in addition to the cost of disposal as non-hazardous, solid industrial, or commercial waste, shall be paid as Extra Work, with provisions subject to testing to verify that the excess material is subject waste.

Table A
Excess Material Management Conditions

EXCESS MATERIAL DESCRIPTION	Subsection in This Specification				
	Conditions on Management by Re-Use	Conditions on Management as Disposable Fill	Conditions on Management by Open Burning	Conditions on Management by Disposal as Non-hazardous Solid Industrial or Commercial Waste	Conditions on Management by Stockpiling
EARTH	Yes	Yes	n/a	Yes	Yes
SWAMP MATERIAL	Yes	Yes TABLE B	n/a	Yes	Yes TABLE B
AGGREGATE	Yes	Yes	n/a	Yes	Yes
ROCK	Yes	Yes	n/a	Yes	Yes
BITUMINOUS PAVEMENT	Yes TABLE B	Not Permitted	n/a	Yes	Yes
CONCRETE	Yes TABLE B	Not Permitted	n/a	Yes	Yes
MASONRY	Yes TABLE B	Not Permitted	n/a	Yes	Yes
MANUFACTURED WOOD	Yes	Not Permitted	Not Permitted	Yes	Yes TABLE B
NATURAL WOOD	Yes	Yes TABLE B	Yes	Yes	Yes TABLE B
DEBRIS FROM OPEN FIRES	n/a	Yes TABLE B	n/a	Yes	Yes TABLE B
METAL/PLASTIC POLYSTYRENE PRODUCTS	Yes	Not Permitted	Not Permitted	Yes	Yes
SUBJECT WASTE	Subject waste shall be managed as specified in the subsection for Conditions on Management by Disposal as Subject Waste.				
MATERIALS SUSPECTED OF BEING CONTAMINATED	When excess materials that were not generated by the Contractor's operations and are not listed in form OPSF 180-4, Subject Waste Classification, are suspected of being contaminated, direction on their management shall be obtained from the Contract Administrator.				
OTHER MATERIALS	Excess materials that are not listed above shall be managed as specified in the subsection for Conditions on Management by Disposal as Non-Hazardous Solid Industrial or Commercial Waste, unless prior alternative management conditions are approved in writing by the Ministry of Environment and Climate Change of Ontario.				

Table B
Excess Material Management Distance Separation Requirements

ADJACENT FEATURE	MINIMUM DISTANCE SEPARATION
Groundwater	2 m (Above)
Waterbodies	30 m
Water Wells	100 m
Residences	100 m

SITE SELECTION NOTIFICATION FOR STOCKPILING MATERIALS MANAGED THROUGH RE-USE

Contract Information

Contract No: _____ Owner: _____

The following describes the notification process between the Owner of the Contract and the Contractor, wherein the Contractor formally notifies the Owner that agreement has been reached with a third party property owner for the stockpiling of Contract generated excess material. Such excess material, stockpiled for re-use or disposal, may be one or a combination of: earth; aggregate; swamp material; rock; concrete; masonry; bituminous pavement; natural wood; metal, plastic, and polystyrene; wood which has been treated, coated, or glued; and debris from open fires, provided the conditions on management are satisfied.

Site Information

Registered Property Owner(s) for the subject property: _____ The subject property:
Lot _____, Concession _____, Township of _____

County/Region/District of _____, Quantity and Type of Excess Material
stockpiled: _____

This is to notify you, as Owner, that permission has been obtained from the property owner(s) named herein for the management of excess materials through re-use from this Contract. The property owner has signed and been provided with a copy of this form and has been advised that a Property Owner's Release Form, OPSF 180-3, will also be required. The use of this management site will comply with the following:

Conditions on Management

It is understood that materials are stockpiled to be re-used or held for disposal at a certified waste disposal site. Stockpiles of natural wood, manufactured wood, debris from open fires, and swamp material may only be located:

- a) A minimum of 2 m above the level of ground water.
- b) A minimum of 30 m from waterbodies.
- c) A minimum of 100 m from any water wells.
- d) A minimum of 100 m from residences.

Stockpiles of bituminous pavement, concrete, and masonry may only be located:

- a) A minimum of 30 m from waterbodies; and
- b) A minimum of 100 m from residences unless

1. on property with a boundary common to a right-of-way, within the contract limits for a period not exceeding 120 calendar days, or
2. such stockpiles are located within a provincial or municipal works yard or in a commercially licensed pit or quarry. I/We state that I/we are the registered owner(s) of the property identified above and I/we agree to sign the Property Owner's Release after the Contractor has placed the excess material on the above-noted property in accordance with the terms of this form.

These conditions do not supersede any constraints imposed on this property by Federal, Provincial or Municipal, including Conservation Authority, statute or regulations and bylaws made thereto.

Dated this _____ day of _____ 20____

Print Contractor's Name & Field Representative's Name

Contractor's Field Representative Signature

Print Registered Property Owner's Name (s)

Registered Property Owner's Signature(s)

cc: Contract Administrator, Property Owner(s), Contractor

SITE SELECTION NOTIFICATION FOR MATERIAL MANAGED AS DISPOSABLE FILL

Contract Information

Contract No: _____ Owner: _____

The following describes the notification process between the Owner of the Contract and the Contractor, wherein the Contractor formally notifies the Owner that agreement has been reached with a third party property owner for the disposition of Contract generated excess material. Such excess material, managed as disposable fill, shall be limited to one or a combination of: earth, aggregate, swamp material, rock, natural wood, and debris from open fires, provided the conditions on management are satisfied.

Site Information

Registered Property Owner(s) for the subject property: _____

The subject property:

Lot _____, Concession _____, Township of _____

County/Region/District of _____, Quantity and Type of Excess Material used as fill:

This is to notify you, as Owner, that permission has been obtained from the property owner(s) named herein for the management of excess materials from this Contract. The property owner has signed and been provided with a copy of this form and has been advised that a Property Owner's Release Form, OPSF 180-3, will also be required. The use of this management site will comply with the following:

Conditions on Management

Swamp material, natural wood, and debris from open fires managed as disposable fill will be top covered by a minimum of 300 mm of earth or topsoil. Swamp material, natural wood, and debris from open fires managed as disposable fill may only be placed:

- a) A minimum of 2 m above the level of ground water.
- b) A minimum of 30 m from waterbodies
- c) A minimum of 100 m from any water wells
- d) A minimum of 100 m from residences.

I/We state that I/we are the registered owner(s) of the property identified above and I/we agree to sign the attached form of Property Owner's Release after the Contractor has placed the excess material on the above-noted property in accordance with the terms of this form.

These conditions do not supersede any constraints imposed on this property by Federal, Provincial, or Municipal, including Conservation Authority, statute or regulations and bylaws made thereto.

Dated this _____ day of _____ 20____

Print Contractor's Name & Field Representative's Name

Contractor's Field Representative Signature

Print Property Owner's Name(s)

Registered Property Owner's Signature(s)

cc: Contract Administrator, Property Owner(s), Contractor

OPSF 180-2

PROPERTY OWNER'S RELEASE

Contract No: _____

Work Description: _____

I/We _____ being the owner(s) of Lot, _____

Concession _____, Township of _____, and County/Region/District of _____, verify that the Contractor for the above noted work has placed excess material from the above noted Contract on my/our property with my/our permission. I/We have signed together with the Contractor OPS Forms 180-1, Site Selection Notification for Stockpiling Materials Managed Through Re-Use, or 180-2, Site Selection Notification for Material Managed as Disposable Fill, or both, that describe Conditions on Management, and have been assured by the Contractor that these conditions have been met.

Quantity and Type of Excess Material used as fill:

Where materials are managed as disposable fill, I/we agree to be responsible for any subsequent relocation and management of the material so placed.

Quantity and Type of Excess Material stockpiled:

Where materials are to be stockpiled, I/We agree that the stockpile(s) will be removed by the date(s) herein noted.

I/We state that I/we are the registered owner (s) of the property identified above and I/we hereby release the Owner and the Contractor in respect of the activities of the Contractor carried out in accordance with this release.

Dated this _____ day of _____ 20____

Print Registered Property Owner's Name (s)

Registered Property Owner's Signature(s)

Print Contractor's Name & Field Representative's Name

Contractor's Field Representative Signature

cc: Contract Administrator, Property Owner(s), Contractor

SUBJECT WASTE CLASSIFICATION

The following named waste is to be disposed of as a subject waste:

The classification of the above waste is as follows:

Shipping Name of Waste	
Reg. 347 Classification	
TDGA Identification No. (PIN)	
TDGA Classification	
TDGA Packaging Group	
Volume of Waste	
Container Type and Condition	

The following named waste is to be disposed of as a subject waste:

The classification of the above waste is as follows:

Shipping Name of Waste	
Reg. 347 Classification	
TDGA Identification No. (PIN)	
TDGA Classification	
TDGA Packaging Group	
Volume of Waste	
Container Type and Condition	

cc: Contract Administrator, Property Owner(s), Contractor

WASTE QUANTITY REPORT

For Solid Non-Hazardous Industrial and Commercial Waste

Contract No: _____

Contractor: _____

Material Description	Location of Disposal Site and Certificate of Approval Number	Quantity of Materials

cc: Contract Administrator, Property Owner(s), Contractor

OPSF 180-5

**Appendix 180-A, November 2016
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS**

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

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Property available for stockpiling for re-use and disposable of fill, or management as disposable fill of excess materials. (180.04.01.01)
- Forest resource licensees within the Contract limits. (180.04.01.03)
- Excess material audit or inventory when required. (180.04.01.06)
- Management conditions of materials with asbestos waste. (180.07.01)
- Identification of waterbodies and sensitive areas. (180.07.01)
- Management by re-use. (180.07.02)
- Management of disposable fill within the Owner's property and on other property. (180.07.03)
- Conditions on management by open burning. (180.07.04)
- Management by disposal of non-hazardous solid industrial or commercial waste. (180.07.05)
- Receiving sites. (180.07.05)
- Management by stockpiling within the Owner's property or on other property. (180.07.06)
- Management of dangerous good waste or subject waste. (180.07.07)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.



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

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182-A	Commentary

182.01	SCOPE

This specification describes requirements that apply to construction involving work in waterbodies and waterbody banks, including temporary watercourse relocations and temporary waterbody crossings.

This specification applies to the work of waterbody and fish habitat protection without limiting the conditions and approvals imposed by statute.

182.01.01 Specification Significance and Use

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

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

182.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

182.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Construction

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

Ontario Provincial Standard Specifications, Material

OPSS 1004	Aggregates - Miscellaneous
OPSS 1860	Geotextiles

Ontario Provincial Standard Form (OPSF)

OPSF 182-1	Permitted Work in Waterbodies, on Waterbody Banks and Adjacent to Waterbodies

182.03 DEFINITIONS

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

Dam means a material or a group of materials that are used to prevent water flow into and out of a work area within a waterbody.

Deleterious Materials means any substance that, if added to a waterbody, could degrade water quality or impact fish, fish habitat and aquatic wildlife.

Flow Control Device means a material or a group of materials that are used to control water flow into and out of a water conveyance device.

Interface means the area of contact between any temporary and permanent waterbody.

Original Watercourse Channel means the channel in which a watercourse was flowing prior to the commencement of the Work.

Plug means the portion of the original bank separating the original watercourse channel from a water conveyance device.

Temporary Waterbody Crossing means a temporary crossing limited to the conveyance of construction equipment and vehicles and includes a fill and culvert, a bridge, or a ford.

Temporary Watercourse Channel means the channel in which a watercourse is flowing at the completion of any relocation sequence from another channel.

Temporary Water Passage System means a dam in conjunction with a water conveyance device, that is used to isolate a work area from a waterbody, and includes a temporary watercourse channel, a fill and culvert, or a pumping or piping system or both.

Waterbody means any lake, pond, watercourse, or fish habitat identified in the Contract Documents.

Waterbody Bank means the area of slopes and flatlands bordering on or adjacent to a waterbody extending a minimum of fifteen metres from the edge of the waterbody.

Water Conveyance Device means a device that is used to move water around or through a work area in a waterbody and includes a flow control device.

Watercourse means a stream, river, creek, municipal drain or canal, and excludes ditches other than those functioning as natural watercourses.

182.04 DESIGN AND SUBMISSION REQUIREMENTS

Two copies of a written strategy shall be submitted to the Contract Administrator for review and permission to proceed with the work at each location in waterbodies and on waterbody banks as specified in OPSF 182-1. This strategy shall be submitted a minimum of 10 Working Days prior to the commencement of work at each location.

For the work at each location, the strategy shall provide descriptions, working drawings, and schedules that fully describe the sequence of the work, the associated waterbody and fish habitat protection, and the related contingency measures associated with each stage of the work. The schedule shall include approximate date of installation, removal, and site restoration.

Such information shall be provided at a level of detail, which addresses materials, equipment, methods employed, and procedures to be followed to provide effective waterbody and fish habitat protection and to comply with statutory authorizations, approvals and permits. The submission shall also include a schedule of checking and monitoring the work to ensure compliance with the strategy.

The strategy shall apply to:

- a) all phases of the work, and transitions between phases of the work.

- b) the installation, operation, and removal of waterbody and fish habitat protection measures, and transitions between any adjacent environmental protection including temporary erosion and sediment control measures.
- c) the interfaces between waterbodies and temporary water passage systems.
- d) the containment or stabilization of disturbed earth material, including and during the winter period and other shutdown periods, to prevent entry of such materials into waterbodies.

The Contract Administrator shall respond within 10 Working Days to each submission or resubmission by either giving permission to proceed, or returning the submission marked "Revise and Resubmit", and giving reasons.

Permission to proceed shall not constitute acceptance of the technical adequacy of the strategy.

Written notification shall be submitted to the Contract Administer 2 Days prior to the actual date of installing or removing protection measures, and initiating or completing other work specified in OPSF 182-1.

182.05 MATERIALS

182.05.01 General

Culvert type, cofferdam and dam material, flow control device, channel lining, and bank protection shall be according to OPSF 182-1.

182.05.02 Cofferdam, Dam and Flow Control Device

A cofferdam, dam, or flow control device shall not contain deleterious material.

182.05.03 Geotextile

Geotextile shall be according to OPSS 1860.

182.05.04 Rip-Rap, Gabion Stone and 19.0 mm Clear Stone

Rip-rap, gabion stone, and 19.0 mm clear stone shall be according to OPSS 1004.

182.05.05 Rounded Stone

Rounded stone shall be no less than 60 mm and no more than 300 mm in dimension and shall be cobbles, pit run fieldstone, or other natural stone material with rounded edges.

182.05.06 Turbidity Curtain

Turbidity curtain geosynthetic and hardware shall be according to OPSS 805.

182.06 EQUIPMENT

All equipment used for work in waterbodies, on waterbody banks, watercourse relocations, and temporary waterbody crossings shall be free of earth material, and excess, loose or leaking fuel, lubricants, coolant and other contaminants that could enter the waterbody.

182.07**CONSTRUCTION****182.07.01****General Requirements**

The work shall be controlled to provide effective waterbody and fish habitat protection. The work shall be monitored, and whenever such protection is found to be ineffective, the Contract Administrator shall be advised, changes to the work shall be made immediately to ensure waterbody and fish habitat protection, and an amendment to the strategy shall be submitted within 10 Days.

Unless specified in the Contract Documents, watercourses shall not be diverted, relocated, or blocked, waterbodies shall not be filled, and temporary waterbody crossings shall neither be constructed nor utilized.

Unless work is specified in waterbodies or on waterbody banks, vehicles and equipment shall not enter or be operated within such areas.

All staff on site shall be briefed about the strategy required in Submission and Design Requirements, and their role in its implementation.

Temporary water passage system, temporary waterbody crossing, cofferdam, turbidity curtain, and temporary erosion and sediment control measures shall be installed prior to commencing the associated work.

Effective mitigation techniques for erosion and sediment control, shall be in place prior to the removal of low vegetative cover and remain effective at all times, including shut down periods.

Vehicular maintenance and refuelling shall be conducted away from waterbodies and waterbody banks. All equipment maintenance and refuelling shall be controlled to prevent any discharge of equipment fuels and fluids onto the ground or into waterbodies.

Excess materials, construction debris, containers, and stockpiles of erodible materials shall be stored to prevent them from entering a waterbody. Such storage areas shall be a minimum of 30 m from a waterbody or temporary watercourses channels.

Water discharge from temporary water passage systems, temporary waterbody crossings, cofferdams, dams, and turbidity curtains shall be controlled so as to prevent entry of deleterious materials into waterbodies, prevent erosion of waterbody bed and banks, and prevent harm to aquatic wildlife.

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

The environmental requirements for blasting in or near waterbodies shall be performed as specified in the Contract Documents.

When working in waterbodies, on waterbody banks, and in temporary watercourse channels:

- a) The work area shall be isolated from those portions of the waterbody or waterbody banks wherein work is not specified.
- b) The extent of disturbance to waterbody bed and banks shall be kept to the minimum necessary for the construction specified in the Contract Documents. The limit of the area to be disturbed shall be clearly marked prior to commencement of the work. The markings shall be maintained for the duration of the Contract. Trees, shrubs, and other vegetation shall be preserved when possible.
- c) The operation of equipment within such areas, the number of entry and exit points, plus the distance from the entry point to the work area, shall be kept to the minimum necessary to perform the specified work.

- d) The work and all subsequent site completion and restoration shall proceed in a continuous fashion so as to minimize its duration.
- e) The work shall not commence while flows are in flood stage.
- f) The work shall be conducted so as to prevent harm to fish and aquatic wildlife and to allow fish passage. When pumping and piping is utilized, the intake hose shall be equipped with a screen to prevent entry of fish and aquatic wildlife. Fish and aquatic wildlife stranded by the work shall be captured and released without harm to the waterbody, or that portion of the waterbody outside the protection system.
- g) Protection measures and work are permitted only at the locations and in compliance with the conditions specified in OPSF 182-1. Timing constraints identified on OPSF 182-1 are in force regardless of the timing of the Contract award. The Owner has obtained the necessary authorizations, approvals and permits for the conditions specified in OPSF 182-1.

182.07.02 Temporary Water Passage System

182.07.02.01 General

The temporary water passage system shall be constructed and fully functional prior to conducting other work in a waterbody or on waterbody banks.

The water conveyance device shall be free of deleterious materials, construction materials, and equipment prior to its use. No release of deleterious materials or sudden surge of water into or out of the water conveyance device shall occur during the opening process.

When a dam is constructed with earth or rock materials on a soft waterbody bed, the first layer of fill shall be rounded stone. The dam shall form a seal around the culvert end, when the water conveyance device is a culvert placed in the original watercourse.

182.07.02.02 Installation

Installation of a temporary water passage system shall be according to the following sequence:

- a) The water conveyance device shall be installed and, when specified in the Contract Documents, channel lining shall be applied. When the water conveyance device is a temporary culvert outside the original watercourse channel or is a temporary watercourse channel, the flow in the original watercourse channel shall remain undisturbed until the water conveyance device is installed. Plugs separating the original watercourse channel and the water conveyance device shall remain in place until the water conveyance device is completed.
- b) The water conveyance device shall be opened to water flow. When the water conveyance device is a temporary culvert outside the original watercourse channel, or when it is a temporary watercourse channel, the water conveyance device shall be opened by completely opening or removing the downstream flow control device prior to the upstream flow control device.
- c) The upstream dam shall be completely installed prior to the downstream dam. If a cover material is specified in the Contract Documents, it shall be applied to each dam immediately upon placement of each dam.

182.07.02.03 Removal

Removal of a temporary water passage system shall be according to the following sequence:

- a) All work in the work area shall be completed.

- b) All materials and equipment not specified to remain in the waterbody shall be removed.
- c) The downstream dam shall be completely removed prior to the upstream dam. Rounded stone in soft waterbody beds shall remain in place whenever it is below the bed level of the waterbody.
- d) The water conveyance device shall be removed. When the water conveyance device is a temporary culvert outside the original watercourses, or is a temporary channel, it shall be closed to flow and removed according to the following sequence:
 - i. An upstream flow control device shall be completely installed prior to a downstream flow control device.
 - ii. The bank shall be restored and, and when specified in the Contract Documents, bank protection shall be applied immediately upon closure or installation of each flow control device.
 - iii. Backfilling and any other work shall be conducted so as to prevent discharge of deleterious materials into the original watercourse.

182.07.03 Temporary Waterbody Crossing

Temporary waterbody crossings shall be constructed at right angles to the waterbody.

When temporary waterbody crossings are constructed with rock materials on soft waterbody beds, a layer of rounded stone shall be placed as a base material. Equipment may enter the waterbody during the crossing construction and removal, provided it is operated on this material bed.

When fill is placed in a waterbody and within 15 m of a waterbody, it shall be rip rap, gabion stone or larger aggregate that meets the same material requirements.

An even driving surface may be constructed only by using rubber mats or 19 mm clear stone placed over a geotextile separator.

Temporary crossings and their approaches shall be constructed and maintained to prevent entry of deleterious material to the waterbody.

Wheeled and tracked vehicles shall be prevented from carrying earth materials that have accumulated in the wheels or tracks onto the crossing.

Fords may be used only when the average waters depth is one metre or less, and conditions are so that it is safe for vehicle crossing. The natural average stream depth at the ford shall be maintained and the approaches clearly marked.

The temporary crossing shall be removed when it is no longer required. All crossing materials shall be removed, unless otherwise specified in the Contract Documents. Rounded stone in soft waterbody beds shall remain in place when it is below the bed level of the waterbody. Immediately upon removal of the temporary crossing, the bank protection, as specified in the Contract Documents, shall be applied and the site shall be restored.

182.07.04 Cofferdams and Turbidity Curtains

Cofferdams and turbidity curtains shall be according to OPSS 805.

182.07.05 Site Restoration

The waterbody and waterbody banks shall be restored to the finished condition specified in the Contract Documents.

182.07.06 Contingency Measures

A standby supply of pre-fabricated silt fence barrier or an equivalent ready-to-install sediment control device sufficient to extend a linear distance of 200 m shall be maintained at the Contract site at all times, including shut down periods, for immediate deployment.

A fully operational standby pump of the same capacity as that specified in OPSF 182-1 shall be maintained at the work site at all times while pumping and piping is being used for temporary waterbody passage.

182.07.07 Management of Excess Material

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

182.10 BASIS OF PAYMENT

Payment at the Contract price for the appropriate tender items requiring work in waterbodies and on waterbody banks shall be full compensation for the labour, Equipment, and Material for the protection of waterbodies and fish habitat.

Appendix 182-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

OPSS 182 and Ontario Provincial Form (OPSF) 182-1 may be required whenever work is proposed in waterbodies and on waterbody banks.

OPSS 182 and OPSF 182-1 should not be included in the Contract, unless necessary authorizations, approvals, and permits can be obtained from the appropriate regulating agencies.

The Owner should complete OPSF 182-1 with the necessary environmental protection information, in consultation with the appropriate regulatory agencies. The completed OPSF 182-1 is to be included in the Contract Documents.

The completed form should reflect the requirements of any formal approvals, permits or authorizations obtained, or the requirements that avoid the need for such authorization. In some cases OPSF 182-1 should refer to the actual authorization attached to the Contract. A blank copy of OPSF 182-1 is attached along with an example of information required to complete the form.

It may be necessary to augment the completed OPSF 182-1 with project-specific Contract Drawings.

Use of the OPSDs listed below are subject to the same conditions and approvals as OPSF 182-1.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Significant Clauses

The requirements of subsection 182.07.01 are intended to avoid unauthorized destruction of fish habitat by the Contractor and thereby minimize the potential for charges being laid against the Owner and Contractor. For this section to be effective, the Owner must ensure that all waterbodies, including seasonally dry fish habitat, within the Contract limits are identified in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 221.010	Temporary Water Passage System, Culvert in Watercourse
OPSD 221.020	Temporary Water Passage System, Pumping and Piping
OPSD 221.030	Temporary Water Passage System, Temporary Channel or Culvert Outside Watercourse
OPSD 221.040	Temporary Waterbody Crossing, Fill and Culvert
OPSD 221.050	Temporary Waterbody Crossing, Ford

Appendix 182-A

PERMITTED WORK IN WATERBODIES, ON WATERBODY BANKS AND ADJACENT TO WATERBODIES

Waterbody and Location	Permitted Protection Measures and Work		Design and Construction Details Including Site Restoration	Timing Constraints (see note)
For each waterbody and location within the Contract limits, specify: 1. waterbody name/location 2. stations and offsets pertinent to the work permitted and the fisheries and protection measures selected.	Temporary Water Passage	Culvert (OPSD 221.010)	Specify # of culverts, culvert dimensions; invert elevations; bedding material; dam material/details; scour protection.	
		Piping and Pumping (OPSD 221.020)	Specify capacity/end points; dam material/details; scour protection.	
		Channel (OPSD 221.030)	Specify end points; channel dimensions; channel lining; flow control device; dam material/details, culvert details as listed below under culvert, if required.	
	Temporary Waterbody Crossing	Fill and Culvert (OPSD 221.040)	Specify # of culverts, culvert dimensions; maximum fill base width; maximum fill elevation; scour protection; waterbody bank protection.	
		Ford (OPSD 221.050)	Specify equipment restrictions; crossings per day; maximum fill base width.	
		Bridge	Specify type of structure; opening dimensions; pier setback; waterbody bank protection.	
	Cofferdam, Dam, Turbidity Curtain		Specify end points; channel dimensions or maximum penetration; maximum dam base width; maximum dam elevation; dam material/details.	
	Isolation of work area from Waterbody and Waterbody Bank.		Specify temporary barricade, identification of area in which any entry is prohibited, etc.	
	Other work in waterbodies and on waterbody banks.		Specify details of permitted work.	

OPSF 182-1

To be completed by the Owner in consultation with regulatory agencies, and is to be used in conjunction with OPSS 182 and shall form part of the Contract Documents. A separate form is required for each work area in waterbodies and on waterbody banks.

Note:

For each protection measure and for any other work, specify one or a combination of:

1. Dates between which protection measure installation is permitted and dates between which protection measure removal is permitted.
2. Dates between which protection measure can be in place; or
3. Maximum period (e.g., # of days) that protection measure can be in place.
4. A separate form is required for each work area in waterbodies and on waterbody banks.

Appendix 182-A

PERMITTED WORK IN WATERBODIES, ON WATERBODY BANKS AND ADJACENT TO WATERBODIES

Waterbody and Location	Permitted Protection Measures and Work		Design and Construction Details Including Site Restoration	Timing Constraints (see note)
	Temporary Water Passage	Culvert (OPSD 221.010)		
		Piping and Pumping (OPSD 221.020)		
		Channel (OPSD 221.030)		
	Temporary Waterbody Crossing	Fill and Culvert (OPSD 221.040)		
		Ford (OPSD 221.050)		
		Bridge		
	Cofferdam, Dam, Turbidity Curtain			
	Isolation of work area from Waterbody and Waterbody Bank.			
	Other work in waterbodies and on waterbody banks.			

OPSF 182-1

To be completed by the Owner in consultation with regulatory agencies, and is to be used in conjunction with OPSS 182 and shall form part of the Contract Documents. A separate form is required for each work area in waterbodies and on waterbody banks.



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

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

202.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

202.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 206	Grading
OPSS 201	Clearing, Close Cut Clearing, Grubbing, and Removal of Surface and Pile Boulders

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 201.

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, submit to the Contract Administrator 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.

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 Excavator

Excavators shall have a minimum operating weight of 30,000 kg and shall be capable reaching to a height of 10 m from ground level.

202.06.04 Hoe-Ram Excavator

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

202.07 CONSTRUCTION

202.07.01 General

The removal of rock by scaling or blasting or both shall include the following:

1. All equipment, including any lifting equipment, materials, and labour that is:
 - a) necessary to gain access to the rock removal locations 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 as a result of the work that may endanger the traveling public.

202.07.02.01.01 Manual Scaling

Manual scaling shall consist of scaling of the rock cut with hand tools and hand-held machine tools by a manual scaling work unit. Manual scaling shall also include:

- a) Rock cut sounding.
- b) Blasting with small quantities of explosives, as specified in the Contract Documents.
- c) Grubbing.

As a minimum, the manual scaling work unit shall consist of the following:

- a) Two labourers experienced in performing scaling work at the heights required in the Contract who have the appropriate safety training.
- b) All tools and materials required for the performance of the work.

202.07.01.02 Machine Scaling

Machine scaling shall consist of scaling of the rock cut by machine scaling work unit. Machine scaling shall also include the following:

- a) Grubbing.
- b) Rock cut sounding.

As a minimum, the machine scaling work unit shall consist of the following:

- a) Either a:
 - i) Excavator equipped with a narrow scaling/ditching bucket; or
 - ii) Hoe-ram excavator.
- b) 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

Trim blasting or controlled blasting shall consist of drilling and blasting to remove the rock specified in the Contract Documents, while minimizing damage to the surrounding rock.

Any loosened or partially-detached rock shall be properly scaled, as specified in Scaling subsection.

202.07.03.02 Trim Blasting

Trim blasting shall also include locating and drilling vertical holes of minimum diameter of 50 mm along the perimeter of the specified trim at a spacing of 750 mm or at a spacing approved by the Contract Administrator.

202.07.03.03 Controlled Blasting

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.

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 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 2016
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS**

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

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Depth of rock removal. (202.06.02)
- Locations necessary to gain access to the rock removal. (202.07.01)
- Removal limits. (202.07.01)
- All blasting, including the use of explosives. (202.07.01)
- Locations and height of removal of scaling. (202.07.02.01)
- Where small quantities of explosives are required with manual scaling. (202.07.02.02)
- Rock that shall be removed by trim blasting or controlled blasting. (202.07.03.01)
- Specify whether excess rock material is to be managed within the right-of-way by slope flattening or other locations. (202.07.04)

The designer should include separate payment item for all associated mucking, hauling, and management of rock material. (202.10.01)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR GRADING

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206-A	Commentary

206.01 SCOPE

This specification covers the requirements for grading, including earth and rock excavation and embankment construction, and management of excavated material.

206.01.01 Specification Significance and Use

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

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

206.01.02 Appendices Significance and Use

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

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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.

206.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 209	Embankment Over Swamps
OPSS 212	Borrow
OPSS 501	Compacting
OPSS 802	Topsoil
OPSS 804	Seed and Cover

Ontario Provincial Standard Specifications, Material

OPSS 1004	Aggregates - Miscellaneous

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 of new fill slopes into existing slopes by excavating horizontal planes in the existing slopes and backfilling the benches and placing the fill simultaneously. Benching also means the stepping of cut slopes at intermediate levels in deep cuts.

Bulking Factor means the ratio of the volume of earth or rock material following excavation, placement, and compacting to the original in situ volume of the same material. The bulking factor for the purposes of this contract 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 specified in the Contract Documents.

Existing Rock Surface means the exposed rock surface or the rock surface after removal of overburden.

Frontslope means the slope in a cut section between the edge of shoulder and the invert of the roadside ditch.

Line Drilling means the placing of a single row of very closely spaced holes without explosives along the rock excavation limits specified in the Contract Documents.

Mucking means the excavation of broken rock.

Overbreak means any broken, displaced, or loosened rock material that originates outside the rock excavation limits specified in the Contract Documents.

Pre-Shearing means the placing of a single row of closely spaced lightly loaded holes placed along the rock excavation limits specified in the Contract Documents, which are fired prior to the main excavation blast.

Profile Grade means the elevation of the surface of the Base as specified in the Contract Documents.

Roadside Ditch means a ditch with one of its sideslopes 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, which may or may not be weathered and includes boulders having a volume of 1 m³ or greater.

Rock Face means the vertical or near vertical face between the top of the existing rock surface and the designated rock or ditch grade line.

Rock Surplus means the rock excavation tender quantity multiplied by the bulking factor minus the rock embankment tender quantity. Rock overbreak and rock materials resulting from scaling are specifically excluded from this definition.

Scaling means the removal of loose, broken, or overhanging rock fragments from a rock face.

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 lay of soil, which is predominantly organic and unsuitable for the construction of embankments. It is commonly referred to as topsoil.

Tolerance means a construction working tolerance only, minus or plus:

a) Minus

- i. Narrower than the Contract standard pertaining to horizontal dimensions as measured from centreline, and
- ii. lower in elevation than the Contract standard pertaining to vertical dimensions.

b) Plus

- i. Wider than the Contract standard pertaining to horizontal dimensions as measured from centreline, and
- ii. higher in elevation than the Contract standard pertaining to vertical dimensions.

Wall Control Blasting means a blasting method using carefully spaced and aligned drill holes intended to produce a relatively flat rock surface, generally characterized by noticeable drill hole traces, with a minimum of blast induced fractures beyond the rock excavation limits 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

When a rock material management plan is specified in the Contract Documents, 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 shown 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 a bulking factor of 1.35 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 to be processed into granular material.
 - v. Excavated rock to be used for other purposes in completing the Work and the type and location of that Work.
 - vi. Excavated rock not incorporated into the Work and the location and use of the material.
- b) A plan for construction of embankments identifying locations and volume in cubic metres from where material is supplied that corresponds to the station intervals in the Contract Documents.

- c) The source locations and volume in cubic metres for additional rock and granular material required to complete the Work.

The Contractor shall update the rock material management plan monthly. The Contractor shall be solely responsible for the assumptions and the reasonableness of the rock material management plan.

206.04.01.02 Trial Section

A minimum of 48 hours prior to commencing any work on the trial section required by the modified layer compaction method, a detailed plan shall be submitted in writing to the Contract Administrator for approval. The plan shall include full details of the placing and compaction procedure, including layer thickness; number and type of compaction units and number of passes; and a method of evaluating the compaction achieved throughout the full lift.

206.06 EQUIPMENT

206.06.01 Tractor Bulldozer, Crawler Type

Tractor bulldozer, crawler type, shall have a minimum net flywheel power of 200 kW.

Rollers for compacting shale embankments shall weigh:

- a) 18 tonnes - first stage.
- b) 9 tonnes, minimum - second stage.

206.07 CONSTRUCTION

206.07.01 General

206.07.01.01 Removal of Ice and Snow

All ice and snow shall be removed from any earth excavation and embankment areas under construction.

206.07.01.02 Embankments

Only materials approved by the Contract Administrator shall be used. Frozen earth materials shall not be incorporated into embankments. Materials shall not be placed over either frozen earth or ice surfaces.

Reclaimed asphalt pavement (RAP) used in embankments shall be surplus to the recycling requirements of the Contract.

206.07.01.03 Compaction

Materials shall be compacted according to OPSS 501.

For the purpose of compaction, RAP and reclaimed Portland cement concrete included in the embankment shall be treated as earth or rock corresponding to the embankment being constructed.

206.07.01.04 Management of Excavated Material

As much of the excavated materials as possible shall be used within the contract limits. Material surplus to embankment requirements or unsuitable material that cannot be accommodated in embankments shall be placed adjacent to the embankments by widening embankments, flattening side slopes, and constructing modified cross-sections, as specified in the Contract Documents or as directed by the Contract Administrator.

Materials that cannot be accommodated as above shall be treated as excess material.

206.07.01.05 Borrow

When borrow is specified in the Contract Documents to complete embankments or backfill requirements, borrow shall be according to OPSS 212.

206.07.01.06 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.

206.07.01.07 Tolerances for Earth

Upon completion, all earth grade surfaces, excluding swamp excavations, shall be shaped to the grades and cross-sections 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 where 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 where 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:

+ 30 mm
- 0 mm

Irrespective of compliance with the above tolerances, the completed slopes shall present a uniform appearance.

206.07.01.08 Tolerances for Rock

Completed rock grade surfaces shall be shaped to the grades and cross-sections specified in the Contract Documents within the following tolerances:

- a) Vertical grading tolerances for the finished rock subgrade within the limits of the roadway:

+ 30 mm
- 100 mm

Excavation below the minus tolerance may be accepted by the Contract Administrator where it is not detrimental to the work and is brought up to grade according to the General clause of the Rock Excavation, Grading subsection.

- 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 where 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 where it is not detrimental to the work.

- e) Vertical grading tolerances for all ditching in rock cuts:

+ 30 mm
- 100 mm

Excavation below the minus tolerance may be accepted by the Contract Administrator where 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 such a manner as to avoid water saturation of embankment material and roadway foundation material and to avoid leaving undrained pockets in rock excavations by providing effective drainage during all stages of the work.

In excavations below subgrade and in stripping operations where 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. Where pipe subdrains are required in the base of roadway cuts, such work shall be carried out at the time that the roadside ditches are being constructed.

206.07.03 Earth Excavation, Grading

206.07.03.01 General

The work shall include excavating, hauling, handling and placing in embankments, shaping, compacting, trimming of earth material and applying temporary cover, and the management of excavated material.

Suitable excavated earth from roadway cuts, ditching, and other associated sites shall be used in embankment construction and as specified in the Contract Documents.

206.07.03.02 Provision for Temporary Cover

Mulch for cover used in temporary applications shall be applied according to OPSS 804 to areas specified in the Contract Documents.

206.07.03.03 Excavation Below Subgrade

Unsuitable materials, other than swamp material, shall be removed below the subgrade to the lengths, widths, and depths specified in the Contract Documents. The resulting excavation shall be backfilled with approved material and compacted.

206.07.03.04 Backfilling of Overexcavated Areas

Where overexcavation occurs, it shall be backfilled with approved material and compacted. With the exception of frontslopes and where boulders are encountered in the excavated slopes, backfilling shall not be permitted to obtain required slopes for excavations. When boulders are encountered in the excavated slopes, the boulders shall be removed when directed by the Contract Administrator and the cavity backfilled with approved material and compacted.

206.07.03.05 Overexcavation of Cut Slopes

Suitable material from overexcavation of cut slopes shall be used in embankment construction.

206.07.03.06 Swamp Excavation

Swamp excavation shall be according to OPSS 209.

206.07.03.07 Stripping

Except where swamp treatment is required, the original ground under embankments of 1.2 m or less in height and the original surface over the entire width of all excavation shall be stripped as specified in the Contract Documents. The height of embankment shall be measured from original ground to profile grade.

Material meeting the requirements of topsoil according to OPSS 802 shall be stockpiled.

Stripped material that does not meet the requirements of OPSS 802 shall be managed as per the Management of Excavated Material clause.

206.07.03.08 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 specified in the Contract Documents. Any such excavation shall be backfilled and compacted with material specified in the Contract Documents prior to closing down operations each day.

206.07.04 Excavation for Pavement Widening

The work shall include excavating a trench adjacent to the existing pavement, to the widths and depths specified in the Contract Documents. Excavated material shall be spread on the adjacent shoulders and slopes.

206.07.05 Rock Excavation, Grading

206.07.05.01 General

The work shall include drilling and blasting to obtain the required rock excavation and shatter, mucking, and bringing to grade any overexcavation. The use of explosives in the blasting operation shall be according to the Contract Documents.

All excavated rock materials, including rock materials resulting from overbreak and scaling, except the quantity of rock surplus, shall be placed in embankments.

Where rock is to be excavated, all overlying stumps, roots, and vegetation shall be treated as excess material. Where earth overlies the rock to be excavated, the earth shall be removed. This work shall be performed sufficiently in advance of blasting operations to allow rock cross-sections to be taken.

Scaling and the removal of all rock or boulders liable to slide or roll down rock cuts either on or outside the excavation areas shall be performed during or after mucking. 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 approved material.

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.

206.07.05.02 Shale

The Contractor shall determine the method of excavation of shale according to site conditions. Side slopes in shale shall be as specified in the Contract Documents. Rock face and shatter are not required in shale.

206.07.05.03 Drilling

All drilling shall be performed within the design excavation limits and to provide shatter as specified in the Contract Documents.

206.07.06 Rock Face

The work shall include drilling and blasting using one or more wall control blasting techniques to produce rock face when specified in the Contract Documents. The work shall also include scaling, removing all overbreak and scaled rock, and incorporating removed rock into embankments.

The spacing and diameter of drill holes for wall control blasting of rock face shall be decided by the Contractor. The spacing and diameter of holes shall be adjusted where necessary to ensure a uniform shear face between holes.

The first line of production holes shall be positioned and loaded with explosives in such a manner as to produce the required rock face.

206.07.07 Earth Embankments

206.07.07.01 General

Embankment material shall be deposited and spread in uniform layers for the full width of the embankment and each layer shall be compacted before the succeeding layer is placed. The lower portion of side hill or sloping sections shall be constructed as above until a full width surface of the specified cross-section is obtained. The embankment shall be completed thereafter with full width layers or as stage construction allows.

The construction of a core through the embankment and the subsequent completion of the embankment are prohibited except where core construction is permitted in swamps as specified in OPSS 209. The use of surplus material and the placing of material in difficult locations by side dumping may be permitted subject to the approval of the Contract Administrator.

Boulders, cobbles, fragments of rock, RAP, and reclaimed concrete material over 150 mm in their maximum dimension shall not be placed within 300 mm of the surface of the earth grade.

Boulders, cobbles, fragments of rock, RAP, and reclaimed concrete material 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.

When the earth embankment has been completed to the limits specified in the Contract Documents, the Contract Administrator shall be notified before placing any surplus, unsuitable material, and topsoil on the embankment slopes.

Topsoil placed on earth embankments shall be according to OPSS 802.

206.07.07.02 Layer Compaction Method

Except as provided in the Modified Layer Compaction Method clause, all earth embankments shall be built using a layer compaction method. The embankment material shall be spread 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 specified before the succeeding layer is placed. All boulders, cobbles, fragments of rock, RAP, and reclaimed Portland cement concrete greater in dimension than the fully compacted layer depth shall be removed.

Where the ground cannot support construction equipment using this method initially, then the first layer may be increased in thickness according to the modified layer compaction method.

206.07.07.03 Modified Layer Compaction Method

When it is deemed practical to construct an earth embankment or portion of an embankment in thicker lifts than specified in the Layer Compaction Method clause, permission may be requested to do so by supplying full details of the proposed method. The maximum thickness of allowable lifts shall not exceed 600 mm. All boulders, cobbles, and fragments of rock shall not exceed the modified layer depth. All RAP and reclaimed Portland cement concrete shall not exceed 300 mm in thickness.

Before placing material, proof of the ability of the proposed method to achieve the specified density shall be demonstrated by means of a trial section consisting of a single uniform lift covering a minimum area of 400 m².

The location and extent of the trial section is subject to approval by the Contract Administrator.

All necessary excavation for establishing the compaction results throughout the layer shall be done by hand.

When the placing and compacting procedure has successfully demonstrated that compaction can be achieved over the entire lift that procedure shall be permitted for the remainder of the work to which it is applicable.

If at any time, test results show that the permitted procedure is no longer producing the required degree of compaction, a new trial area shall be required. Changes in the procedure shall be made to satisfy the requirements of this specification. Such changes shall be in writing to the Contract Administrator before commencing work on the new trial area.

206.07.08 Rock Embankments

206.07.08.01 General

The work shall include, hauling, placement, and compaction of broken rock.

Each rock fill layer shall be compacted with a tractor bulldozer, crawler type. The minimum number of complete passes is six and the maximum number of passes is eight. A complete pass is 100% coverage of the layer surface. The maximum speed of the equipment during each pass shall be 3.2 km/h.

Embankments to be constructed of rock other than shale shall be constructed by placing embankment materials full width in successive, uniform layers. Layers shall not exceed 1.5 m thickness prior to compaction. Material in each layer shall be fully compacted before the succeeding layer is placed.

Materials shall be placed in 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.

Rocks fragments exceeding a maximum dimension of 1 m shall be well distributed throughout the embankment. Rock fragments up to a maximum size of 3 m in size 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 are sufficiently spaced to allow free access of the specified equipment to compact the intervening fill.

Placement and compaction in layers are not required for rock to be placed under water. Rock placed underwater may be placed by end dumping. End dumping shall only be used to an elevation of 1.0 m above the water level after which the rock embankment shall be constructed using the equipment and method specified. The materials shall be well distributed to form a solid embankment constructed to full width as the work progresses, or as stage construction allows.

Where 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 such that mud waves generated by the rock placement would move away from the embankment. Mud waves shall be displaced or removed to prevent its entrapment below or within the embankment.

Voids on the top surface of the embankment shall be minimized to prevent migration of the roadway subbase and base into the rock fill embankment by chinking the top surface with rock fragments and spalls to form the subgrade prior to the placement of the roadway subbase.

Care shall be taken to avoid large boulders and rock fragments protruding above the average embankment surface within a distance of 3.0 m beyond the edge of shoulder.

Dumping of surplus rock over the sides of embankments is permitted only after the rock embankments have been completed. Dumping over the sides of embankments shall be restricted to areas not affecting features within the right-of-way (e.g., ditches, culverts, and signs) or right-of-way limits. The Contractor shall receive written approval from the Contract Administrator before commencing these operations.

When the rock embankment has been completed, the Contract Administrator shall be notified before placing any surplus, unsuitable material, and or top soil on the embankment slopes.

206.07.08.02 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. Where a harder more durable rock, such as limestone, is present as an integral part of a shale formation, no pieces greater than 150 mm measured vertical to the embankment layer, or greater than 600 mm measured parallel to layers shall be placed in the embankment.

Compaction of each layer shall be in two stages. In the first stage, a minimum of two passes shall be made with a static sheepsfoot, packall, padfoot, or tamping foot type roller. In the second stage, a minimum of two passes shall be made with a vibratory steel drum or pneumatic-tired roller. Maximum speed of rollers shall not exceed 10 km/hr.

When the shale embankment has been completed, the Contract Administrator shall be notified before placing any surplus, unsuitable material, and or top soil on the embankment slopes.

206.07.08.03 Rock Backfill to Structure

When rock backfill to structures is specified, the rock shall be clean, free from contaminants, with no fragments larger than 250 mm in its greatest dimension.

Rock backfill shall be placed in such a manner that the structure is not damaged. Dumping of rock backfill against a structure shall not be permitted.

206.07.09 Quality Control

206.07.09.01 General

The Contractor shall be responsible for carrying out all quality control grade checks to ensure that horizontal and vertical grading tolerances are met.

206.07.09.02 Submission of Grade Checks

All grade checks relating to horizontal and vertical grading tolerances, including all non-compliances, shall be submitted to the Contract Administrator within 2 Business Days following completion of the grade.

Where grading templates are available, the Contractor shall sign and certify the template as correct. If no template is available, the Contractor shall complete, sign, and submit the attached form OPSF 206-1 to the Contract Administrator.

206.07.09.03 Finished Grades Outside Specification

Where the finished grade or cross-section does not meet the requirements of the Contract Documents, the earth or rock grade surface shall be brought to grade within the specified tolerances.

206.07.10 Management of Excess Material

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

206.08 QUALITY ASSURANCE

The Contract Administrator may conduct random quality assurance grade checks to verify horizontal and vertical grading tolerances. If the finished grade or cross-section is found to be outside the specified tolerances, the Contractor shall be required to bring the earth or rock grade within the specified tolerances.

206.09 MEASUREMENT FOR PAYMENT

206.09.01 Actual Measurement

206.09.01.01 Earth Excavation, Grading

Measurement of earth excavation, grading, shall be by volume in cubic metres measured in its original position and based on cross-sections taken prior to grubbing.

Benching of slopes shall not be measured.

206.09.01.01.01 Overbuilding, Earth

Where the Contract requires borrow, the quantity of material placed beyond the earth grading tolerance shall be deducted from the measured quantity of borrow on a cubic metre for cubic metre basis, with no correction for changes in density of the material.

206.09.01.02 Excavation for Pavement Widening

Measurement of excavation for pavement widening shall be the horizontal length in metres along each edge of existing pavement where 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 by volume in cubic metres computed from field measurement of cross-sections taken after earth overburden has been removed and shall be based on the designated limits. The theoretical bottom of the cut shall be the shatter line, which shall be 300 mm below the rock grade.

The quantity of rock beyond that specified in the Contract Documents, as ordered by the Contract Administrator in writing, shall be included in the rock excavation computation.

Deductions shall not be made from the rock excavation quantity for any material conforming to OPSS 1004 and used as rip-rap or rock protection.

206.09.01.03.02 Overbuilding, Rock

Where the Contract requires borrow, the quantity of material placed beyond the rock grading tolerance at the top of subgrade and beyond the angle of repose for rock fills, below the subgrade, shall be deducted from the measured quantity of borrow on a cubic metre for cubic metre basis, with no correction for changes in density of the material.

206.09.01.03.03 Boulders

The volume of boulders classified as rock shall be determined on the basis of actual rock measurement.

206.09.01.04 Rock Face

Measurement of rock face shall be by area of the rock face in square metres.

206.09.01.05 Rock Embankment

Measurement of rock embankment shall be by volume in cubic metres of the material placed within the embankment.

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.

Benching of materials excavated as required to key new fills into existing slopes shall not be included for payment.

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.

Material used to backfill the excavation shall be paid for at the Contract price for the tender item of the material used.

Where the Contract Administrator directs that material excavated under this item is to be managed other than as specified in the Excavation for Pavement Widening subsection, then such material shall be managed as excess materials as specified in the Contract Documents and shall be paid as Extra Work.

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 embankments shall be included in the rock excavation, grading item.

When excavated rock is to be used for other Contract item work (e.g., rock embankment, granular, and rip-rap) the hauling costs are deemed to be included in payment for the work associated with the appropriate tender item.

Where 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.

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.

On completion of drilling and blasting, a progress payment of 50% of the above item shall be made.

On completion of mucking, a progress payment of 75% shall be made.

206.10.05 Rock Embankment - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

When the Contract does not contain a separate tender item for rock embankment, the Contract price for Rock Excavation, Grading, shall include full compensation for all labour, Equipment, and Material to do the work of rock embankment.

206.10.06 Backfill for Overexcavation

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

206.10.07 Backfill for Subexcavation

Material used to backfill subexcavations and transition or grade point treatments shall be paid for at the Contract price for the tender item of material used.

206.10.08 Finished Grades Outside Specification

When finished grades are outside specifications, bringing the earth or rock surface to grade within the specified tolerances shall be at no extra cost to the Owner.

206.10.09 Rock Borrow

When the Contract does not contain sufficient rock within the Contract limits and the Contract does not contain a rock embankment item, rock borrow shall be paid according to OPSS 212.

CERTIFICATION OF GRADE ELEVATION / CROSSFALL

CONTRACT _____ **LOCATION** _____

COMPONENT _____ **LOCATION** _____

In compliance with the Contract, I hereby certify that the following portions of the above component of the work have been correctly constructed to the specified line and grade tolerances.

FROM STATION	TO STATION	TYPE OF GRADE	DATE	CERTIFIED BY	
				Print Name	Signature

OPSF 206-1

Appendix 206-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

The designer should specify the following in the Contract Documents:

- Locations for use of excavated material. (206.07.01.04)
- Areas requiring temporary cover. (206.07.03.02)
- Location and extent of unsuitable material below subgrade to be removed. (206.07.03.03)
- The stripping limits. (206.07.03.07)
- The maximum limit of open excavation allowed adjacent to the travelled roadway. (206.07.03.08)
- The widths and depths when excavation is required adjacent to the travelled roadway. (206.07.04)

The designer should determine if the following is required and, if so, specify it in the Contract Documents:

- Rock material management plan. (206.04.01.01)
- Borrow requirements. (206.07.01.05)
- Rock face item. (206.07.06)
- Rock embankment item. (206.10.05)

The designer should be aware that in estimating fill quantities, where displacement may be anticipated, an allowance should be made for losses into bottom of fills in material due to displacement.

Consideration should be given to the use of trial blast over a limited extent to ensure that the method spacing and diameter wall control blast holes are properly selected to achieve an acceptable rock face for the given rock condition.

On reconstruction projects, areas of subgrade shatter, rock fill, and previously blasted rock to be removed should be clearly defined in terms of location, depth, etc.

When a rock embankment item is not included in the Contract, the designer should include a rock borrow item if there is insufficient rock within the Contract limits.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Appendix 206-A

Related Ontario Provincial Standard Drawings

OPSD 200.010	Earth/Shale Grading, Undivided Rural
OPSD 200.020	Earth/Shale Grading, Divided Rural
OPSD 201.010	Rock Grading, Undivided Rural
OPSD 201.020	Rock Grading, Divided Rural
OPSD 202.010	Slope Flattening Using Excess Material on Earth or Rock Embankment
OPSD 202.020	Drainage Gap for Slope Flattening on Rock or Granular Embankment
OPSD 202.030	Embankment Widening for Guide Rail End Treatments and Transitions
OPSD 203.010	Embankments Over Swamp, New Construction
OPSD 203.020	Embankments Over Swamp, Existing Slope Excavated to 1H:1V
OPSD 203.030	Embankments Over Swamp, Existing Slopes Maintained
OPSD 203.040	Embankments Over Swamp at Pipe Culverts $\leq 1500\text{mm}$
OPSD 204.010	Boulder Treatment, Cut Sections - Subgrade
OPSD 205.010	Transition Treatment, Earth Cut to Earth Fill
OPSD 205.020	Transition Treatment, Rock Cut to Rock Fill
OPSD 205.030	Transition Treatment, Rock Cut to Earth Fill
OPSD 205.040	Transition Treatment, Earth Fill to Rock Fill and Earth Fill to Granular Fill
OPSD 205.050	Transition Treatment, Rock Cut to Earth Cut
OPSD 205.060	Frost Heave Treatment
OPSD 208.010	Benching of Earth Slopes
OPSD 209.010	Rural Pavement Widening
OPSD 209.011	Rural Pavement Widening with Curb and Gutter
OPSD 209.020	Widening, Existing Rock Cut with Grade Raise
OPSD 300.010	Side Road Intersection, Fill
OPSD 300.020	Side Road Intersection, Cut
OPSD 301.010	Rural Entrances to Roads on Fill
OPSD 301.020	Rural Entrances to Roads in Earth Cut With Culvert Installation
OPSD 301.030	Rural Entrance, Rock Cut



CONSTRUCTION SPECIFICATION FOR EMBANKMENTS OVER SWAMPS AND COMPRESSIBLE SOILS

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209.01 SCOPE

This specification covers the requirements for the construction of embankments over swamps and compressible soils using the excavation, floatation, or displacement method.

209.01.01 Specification Significance and Use

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

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

209.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

209.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 201	Clearing, Close Cut Clearing, Grubbing, and Removal of Surface and Piled Boulders
OPSS 206	Grading
OPSS 212	Borrow

Ontario Provincial Standard Specifications, Material

OPSS 1010	Aggregates - Base, Subbase, Select Subgrade, and Backfill Material
OPSS 1860	Geotextiles

209.03 DEFINITIONS

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

Displacement Method means to build the embankment directly on the swamp such that the underlying swamp material is displaced away from the embankment fill.

Earth means as defined in OPSS 206.

Floatation Method means to build the embankment directly on the swamp minimizing the displacement of the swamp material.

Rock means as defined in OPSS 206.

Hydraulic Backhoe Reach means the distance from the bottom of the tracks to the tip of the bucket teeth when measured vertically with the bucket at the lowest point of the bucket swing path.

Swamp Material means the material within the swamp excavation, floatation, or displacement limits, except rock, masonry, natural wood, and manufactured products. Wood that has decomposed and breaks down readily upon handling shall be considered swamp material.

Swamp Wave means the swamp material that is displaced as a result of placement of embankment material.

209.05 MATERIALS

209.05.01 Embankment Material

Embankment material shall consist of earth, rock, select subgrade material, or other material specified in the Contract Documents.

209.05.01.01 Earth Borrow or Rock Borrow

Earth borrow or rock borrow shall be according to OPSS 212.

209.05.01.02 Select Subgrade Material

Select subgrade material shall be according to OPSS 1010.

209.05.02 Geotextile

Geotextile shall be according to OPSS 1860 and be of the type, class, and filtration opening size (FOS) range specified in the Contract Documents.

209.06 EQUIPMENT

209.06.01 Rented Swamp Excavator

The type of swamp excavator equipment shall be as specified in the Contract Documents.

The minimum size and requirements shall be a 26,500 kg crawler mounted hydraulic backhoe with a minimum 12 m reach and a 1 m³ bucket or a 40,000 kg crawler mounted dragline with a 1.15 m³ bucket. Buckets shall be suitable for swamp excavation.

209.06.02 Spreading, Levelling, and Compacting Equipment

When the floatation method is used, spreading, levelling, and compacting equipment shall be restricted to a gross weight that is not detrimental to the structural integrity of the root mat.

209.07 CONSTRUCTION

209.07.01 General

The work of embankment construction shall be carried out using one or more of the following methods specified in the Contract Documents:

- a) Excavation Method

b) Floatation Method

c) Displacement Method

209.07.02 Clearing and Close Cut Clearing

Prior to beginning embankment construction, the required clearing and close cut clearing shall be completed according to OPSS 201. Close cut clearing shall be carried out in such a manner as not to damage the structural integrity of the root mat.

209.07.03 Excavation Method

The work shall include the excavation of all material, except rock from within the limits specified in the Contract Documents and the handling, placing, shaping, trimming and hauling of excavated material.

Excavation shall be to the full width and full depth. The excavation and backfilling shall be a controlled operation and shall be carried out simultaneously.

Excavated material shall be placed clear of the sides of the embankment limits and any drainage facilities.

209.07.03.01 Embankment Construction and Backfill

Backfill shall be placed according to OPSS 206. However, when wet conditions exist, backfill material other than rock may be placed up to 600 mm above water level without compaction.

Embankment material placed subsequent to the backfill material shall be placed according to OPSS 206.

209.07.04 Floatation Method

The work shall consist of controlled placement of embankment material, removal of surcharges specified in the Contract Documents from above the subgrade, and hauling and incorporating of the surcharge material into the work according to OPSS 206.

209.07.04.01 Swamp Waves

Swamp waves shall not be excavated or otherwise disturbed.

209.07.04.02 Embankment Construction

The embankment shall be constructed according to OPSS 206, except that vibratory compaction equipment shall not be used within 1.0 m of the original surface of the swamp.

Each layer shall be built using an outside to inside sequence by keeping the outer one-third portions of the layer at least 30 m ahead of the centre portion.

209.07.04.03 Geotextile

When geotextile is to be placed, the area specified in the Contract Documents for geotextile shall be close cut cleared and cleared of objects that may damage the geotextile.

The placement operation shall be such that the geotextile is not exposed to daylight for more than 72 hours.

Adjacent sections of the geotextile shall be overlapped a minimum of 1.0 m or shall be sewn together according to OPSS 1860.

Where geotextile is damaged, it shall be repaired by the removal of the embankment material and placing a piece of geotextile large enough to cover the damaged section meeting the above requirements for overlapping.

209.07.05 Displacement Method

The work shall consist of controlled placement of the embankment material, excavation of swamp waves and displaced material, removal of surcharges specified in the Contract Documents, and hauling and incorporating of this material into the work according to OPSS 206.

209.07.05.01 Embankment Construction

The embankment shall be built in such a manner as to displace as much of the material underlying the embankment as possible. An inside to outside construction sequence shall be used, keeping the inside one-third portion 30 m ahead of the outside portions.

When a stable platform has been established, embankment material placed 300 mm above the original surface of the swamp shall be placed according to OPSS 206.

209.07.06 Management of Excess Material

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

Manufactured products shall not be used in the right-of-way.

Excavated swamp material shall be used as much as possible within the right-of-way adjacent to an embankment and conforming to standard right-of-way offset. This shall be done by widening embankments, flattening side slopes, and constructing modified cross-sections as specified in the Contract Documents. Such material shall be trimmed to provide smooth contours and to provide drainage.

The volume of excavated material to be used within the Contract limits or designated areas shall be as specified in the Contract Documents.

209.09 MEASUREMENT FOR PAYMENT

209.09.01 Actual Measurement

209.09.01.01 Excavation

Measurement shall be by volume in cubic metres by the method of average end areas. The quantity for payment shall be the lesser of the following:

- a) Actual excavation.
- b) Excavation to the length, width, and depth as specified in the Contract Documents.

209.09.01.02 Rental of Swamp Excavation Equipment

Measurement shall be by time in hours that the equipment is in effective operation. When hauling is required, the equipment shall not be considered in effective operation when there are no trucks ready for loading.

When the excavated material has been placed in a location that will not interfere with subsequent excavation, measurement shall not be made for the handling required in grading, levelling, and trimming of such material.

209.09.01.03 Select Subgrade Material

Measurement shall be by mass in tonnes or by volume in cubic metres as specified in the Contract Documents.

209.09.01.03.01 Cubic Metre Measurement

When measurement of select subgrade material is in cubic metres, one of the following methods, as specified in the Contract Documents, shall be used to calculate the volume of the material:

a) End Area Method

Volume of material shall be measured in its original location and computed in cubic metres by the method of average end areas.

Original cross-sections shall be taken after the area has been cleared, grubbed, and stripped of unsuitable surface material. These operations shall be completed a minimum of 3 Working Days in advance of excavation to allow for the required cross-sectioning.

b) Truck Box Method

Material shall be measured in cubic metres, loose, by predetermined truck box capacities. The predetermined capacity of each truck shall be that computed from its box dimensions.

Each truck shall be uniquely and readily identifiable.

209.09.01.04 Geotextile

Measurement shall be by area, in place, in square metres, with no allowance for overlaps.

209.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

209.10 BASIS OF PAYMENT

209.10.01 Excavation

Payment for swamp excavation shall be at the Contract price for the tender item Earth Excavation, Grading, according to OPSS 206.

Payment shall not be made for the removal of materials that slide or slough inside the excavation limits.

209.10.02 Rental of Swamp Excavation Equipment, Dragline - Item Rental of Swamp Excavation Equipment, Hydraulic Backhoe - Item

Payment at the Contract price for the above tender items shall be full compensation for furnishing and operating the minimum size equipment specified, including mats, when necessary, for the excavation and for the management of the material adjacent to the excavation.

Payment for drainage of water in swamps prior to excavation is included in these tender items unless otherwise specified elsewhere in the Contract Documents.

When the Contract Administrator approves the use of larger equipment, the Contract price per hour shall be adjusted by adding to the Contract price the difference between the rate set out in the Contract Documents for the minimum size equipment specified and the rate set out in the Contract Documents for the larger equipment to be employed.

Where the standard operating weight for the equipment falls between increments and listed categories shown in the Contract Documents the lower rate shall apply. No interpolation between categories of standard operating weights will be made to determine payments. When larger equipment is approved for use, the estimated hours of swamp excavation equipment rental will be adjusted down by the Contract Administrator.

209.10.03 Floatation and Displacement Method

Payment shall not be made for swamp material displaced by floatation or displacement.

**209.10.04 Select Subgrade Material - Item
Geotextile - Item**

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Repairs to geotextile damaged by the Contractor's operation shall be at no additional cost to the Owner.

209.10.05 Management of Swamp Material Excavated by Equipment Rental

All costs associated with the management of material except trucking are deemed to be included in the Contract unit price for rental of equipment.

Material resulting from the operation of the above equipment shall be managed as specified in the Contract Documents.

**Appendix 209-A, November 2015
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS**

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

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Alternative materials allowed in embankment construction (e.g., expanded polystyrene, wood chips, bark, and granular blast furnace slag). (209.05.01)
- Woven or non-woven, class of fabric, FOS, and thickness of material for geotextile. (209.05.02)
- One or more of the methods of embankment construction. (209.07.01)
- Maximum volume and locations of excavated material to be placed within the Contract limits. (209.07.07)
- Method of measurement for select subgrade material. (209.09.01.03)
- Method of calculation for cubic metre measurement, if required. (209.09.01.03.01)

The designer should determine if the following is required and, if so, specify it in the Contract Documents:

- Type of rental swamp excavation equipment. (209.06.01)

The designer should include the rental of swamp excavation equipment item when recommended by an Engineer.

The designer should specify whether payment for drainage of water in swamps is included in the rental of swamp excavation equipment item or included as a separate item.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standards Drawings

OPSD 203.010	Embankments Over Swamp, New Construction
OPSD 203.020	Embankments Over Swamp, Existing Slopes Excavated to 1H:1V
OPSD 203.030	Embankments Over Swamp, Existing Slopes Maintained
OPSD 203.040	Embankments Over Swamp at Pipe Culverts $\leq$ 1500 mm



CONSTRUCTION SPECIFICATION FOR BORROW

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212.01 SCOPE

This specification covers the requirements for earth borrow and rock borrow.

212.01.01 Specification Significance and Use

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

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

212.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

212.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 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

212.03 DEFINITIONS

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

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

Borrow means earth or rock material acquired from outside the right-of-way to complete the Work.

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

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 earth borrow material being used in the Work, a list of intended borrow sources and the tonnage that is expected to be used from each source shall be provided to the Contract Administrator to allow time for sampling and testing.

A minimum of 48 hours prior to the placement of borrow in the Work, the following shall be submitted to the Contract Administrator:

- a) Written proof for the right to occupy and operate each borrow source, including all appropriate permits.
- b) A plan outlining the use of frost susceptible earth borrow.

212.05 MATERIALS

212.05.01 Earth Borrow

Earth borrow shall consist of earth or shale as defined in OPSS 206 and shall be free from organic and foreign material.

Earth borrow with at least 50% of the particles by mass between 5 and 75 μm , as determined by LS-702, shall be considered frost-susceptible.

212.05.02 Rock Borrow

Rock borrow shall consist of rock as defined in OPSS 206, excluding shale.

212.07 CONSTRUCTION

212.07.01 General

The work required for borrow shall include clearing, grubbing, and stripping of borrow source; construction and maintenance of access roads; excavating, hauling, placing, and compacting the 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

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. These operations shall be completed a minimum of 3 Working Days in advance of excavation when 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, Contractor, and the owner of the haul road.

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 material that is not free from organic or foreign material.

All samples shall be obtained by the Contractor in the presence of the Contract Administrator or a designated representative. Notwithstanding, the Owner may take samples for its own purposes at any time from any location. The Contractor shall provide assistance to the Owner in obtaining samples.

The Contractor shall supply sample containers.

The Contractor shall place bags or containers of samples into clear polyethylene security bags supplied by the Owner when instructed by the Contract Administrator. The Contract Administrator or his representative may apply security seals.

All samples, including those handled by a commercial carrier, shall be accompanied by a sample data sheet identifying the following information:

- a) Contract Number.
- b) Name of Contractor and a contact person's name and telephone numbers.
- c) Contract Administrator's name and telephone numbers.
- d) Date sampled (i.e., yyyy-mm-dd).
- e) Date shipped (i.e., yyyy-mm-dd).
- f) Source name and location.
- g) Test hole number and location.
- h) Sample number and soil type.

All QA samples shall be delivered to the QA laboratory as specified in the Contract Documents.

212.08.02 Earth Borrow Source

Except when referee testing is invoked, QA test results shall be used for acceptance purposes. When QA test results show that the earth borrow meets the material requirements of this specification, the earth borrow source shall be accepted.

A minimum of one QA sample per soil type per source shall be tested to verify the material meets the requirements of this specification. Additional QA samples may be taken at anytime. QA samples shall be taken in duplicate. One sample shall be tested for QA purposes. The remaining sample shall be used for referee testing, if invoked by the Contractor.

When QA test results show that the earth borrow does not meet the material requirements of this specification, the Contract Administrator shall notify the Contractor that the material represented by the QA test results is not acceptable. This notification shall take place in writing within 1 Business Day of receipt of the non-conforming data.

212.08.02.01 Referee Testing

When QA test results do not meet the requirements of this specification, the Contractor has the option of invoking referee testing of the test result that failed to meet the requirements. The Contractor shall notify the Contract Administrator in writing invoking this option within 2 Business Days following notification of unacceptable material. The notification shall include the material and specific attribute or attributes for which the referee testing is being requested.

The Contract Administrator shall select a referee laboratory acceptable to the Contractor within 3 Business Days following the Contractor's notification to invoke referee testing. Referee samples shall be delivered to the referee laboratory from the QA laboratory by the Contract Administrator. If referee samples are not available, the Contractor shall be responsible for obtaining and submitting new samples to the referee laboratory from a location to be decided by the Contract Administrator. The Contract Administrator shall be present to witness the sampling.

Referee testing shall be carried out in the presence of the Contract Administrator. The Contractor may observe the testing. Owner and Contractor observers shall be permitted to validate sample identification, view sample condition, observe test procedures, take notes, view equipment readings, and review completed work sheets while in attendance. Concerns with sample condition or sample identification shall be made prior to commencement of referee testing. Comments on deviations from the applicable test method shall be made immediately and corrected at the time of testing. Unresolved concerns shall be specific in nature and submitted in writing to the laboratory's designated representative and other observers at the time of testing. Referee test results shall be binding on both the Owner and the Contractor.

When a referee test result shows that the material does not meet the requirements of this specification, the material represented by the test result, including material in existing stockpiles or in the Work, shall not be accepted and the materials shall be removed.

When a referee test result shows that the material is in conformance with the requirements of this specification, the material represented by the sample shall be accepted.

212.08.03 Earth Borrow

The Contract Administrator reserves the right to visually identify localized soft spots. The Contractor shall remove the identified soft spots and backfill the resulting void with approved material.

212.09 MEASUREMENT FOR PAYMENT

212.09.01 Actual Measurement

212.09.01.01 Earth Borrow and Rock Borrow

Measurement of earth borrow and rock borrow shall be by mass in tonnes or by volume in cubic metres as specified in the Contract Documents.

When earth borrow and rock borrow is measured by volume, one of the following methods, as specified in the Contract Documents, shall be used to calculate the volume of the material:

a) End Area Method

i. At Source

Material shall be measured at the source in its original location by the method of average end areas.

Cross-sections shall be taken after the source has been cleared, grubbed, and stripped of all unsuitable surface material.

The volume of boulders removed from borrow pits that cannot be accommodated in embankments shall be deducted.

ii. In Place

The material shall be measured in place with no allowance for shrinkage by the method of average end areas.

b) Truck Box Method

The material shall be measured loose by predetermined truck box capacities and an appropriate bulking factor as determined by the Contract Administrator. The predetermined capacity of each truck shall be that computed from its box dimensions.

Each truck shall be uniquely and readily identifiable.

212.10 BASIS OF PAYMENT

**212.10.01 Earth Borrow - Item
Rock Borrow - Item**

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Removal and replacement of localized soft spots identified by the Contract Administrator shall be at no extra cost to the Owner.

Removal of unacceptable material shall be at no extra 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.

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

The designer shall specify the following in the Contract Documents:

- Frost penetration depth. (212.07.01)
- Areas where frost-susceptible borrow is not to be placed. (212.07.01)
- Who delivers the QA samples to the QA laboratory. (212.08.01)
- The method of measurement for earth borrow and rock borrow. (212.09.01.01)
- The method of calculation of volume of material if measurement is by volume. (212.09.01.01)

All acceptable fill material should be considered for embankment construction, prior to selecting either earth borrow or rock borrow as a construction alternative.

The designer should determine if material from Owner sources is available and, if so, the designer should specify this information in the Contract Documents. (212.07.03)

When borrow sources are known, they should be identified in the Contract Documents.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR WICK DRAIN INSTALLATION

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220.08	QUALITY ASSURANCE
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220.10	BASIS OF PAYMENT

APPENDICES

220-A	Commentary

220.01 SCOPE

This specification covers the requirements for the supply and installation of wick drains, including a granular blanket.

220.01.01 Specification Significance and Use

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

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

220.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

220.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 206	Grading
OPSS 501	Compacting

Ontario Provincial Standard Specifications, Material

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

Canadian General Standards Board (CGSB)

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.

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

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

220.06.01 General

The equipment used to install wick drains shall be of the type that minimizes the disturbance to the drainage blanket or the native subsoil during the installation operation.

Falling weight impact hammers shall not be permitted.

220.07 CONSTRUCTION

220.07.01 Operational Constraints

When a site is designated as an environmentally sensitive area, jetting techniques shall not be permitted.

Wick drains shall be installed subsequent to the construction of the granular blanket and prior to the installation of monitoring instruments and placement of any overlying material. Wick drains shall be protected by a minimum of 2 m of earth fill or 4 m of rock fill before the ground freezes. Wick drains shall not be installed in frozen ground.

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 the 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 2 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 Granular Blanket

Measurement of the granular blanket shall be by mass in tonnes. Weighing of the material shall be as specified in the Contract Documents.

220.09.01.02 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 Granular Blanket - Item
Wick Drains - Item**

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

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.

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

The designer should specify the following in the Contract Documents:

- Requirements for excavation and backfill of unsuitable material. (220.07.03)
- Limits and grade of the granular blanket. (220.07.03)
- Depth of installation of wick drains. (220.07.05.01)
- Location and spacing requirements for wick drains. (220.07.05.02)

When there is significant variance in embedment depth, the designer should consider having more than one pay item based on depth.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR PRIMING GRANULAR BASE

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302-A	Commentary

302.01 SCOPE

This specification covers the requirements for surface preparation and application of bituminous primer on a granular base and placement of a sand cover to accommodate traffic.

302.01.01 Specification Significance and Use

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

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

302.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

302.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 304 Single and Double Surface Treatment

Ontario Provincial Standard Specifications, Material

OPSS 1006 Aggregates - Surface Treatment
OPSS 1102 Liquid Asphalt
OPSS 1103 Emulsified Asphalt

Ministry of Transportation Publications

MTO Laboratory Testing Manual

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

302.03 DEFINITIONS

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

Appurtenances mean maintenance hole, catch basin, valve chamber, and water valve covers and similar Utility access covers located within the pavement portion of the roadway.

Lot means the quantity of work completed with a tanker truck shipment of primer.

Primer means the emulsified asphalt or low viscosity liquid asphalt sprayed on a prepared granular base.

Sand Cover means an aggregate applied over the primer to blot the primer and permit the passage of traffic.

302.05 MATERIALS

302.05.01 Primer

Primer shall consist of one or more of the following types of asphaltic materials:

- a) Emulsified Asphalt Primer according to OPSS 1103.
- b) MTO Primer or RC-30 according to OPSS 1102.

302.05.02 Sand Cover Aggregate

Aggregate shall be a Class 4 aggregate according to OPSS 1006.

302.06 EQUIPMENT

302.06.01 Pressure Distributor

The pressure distributor shall be designed and manufactured to spray primer uniformly on the road surface. The pressure distributor shall be capable of applying primer at the specified rates and in a continuous and uniform manner both longitudinally and transversely for a full lane width.

302.06.02 Mechanical Aggregate Spreader

The mechanical aggregate spreader shall be designed and manufactured to be self-propelled and capable of continuously and uniformly distributing aggregate on the primed granular base at the specified application rate.

302.06.03 Pilot Vehicle

The pilot vehicle shall be equipped according to the requirements of the OTM, Book 7.

302.06.04 Rollers

Rollers shall be according to OPSS 304.

302.07 CONSTRUCTION

302.07.01 Operational Constraints

Primer shall not be applied when the ambient temperature at the work location is less than 10 °C or when climatic conditions preclude the curing of the primer.

Primer shall not be applied prior to May 15th south of a line through Pembroke, Magnetawan, and Pointe au Baril Station and not prior to June 1st north of the line.

Emulsified primers shall not be applied after September 1st except with the approval of the Contract Administrator. .

The placing of aggregate shall be terminated one hour before sunset.

302.07.02 Sampling

302.07.02.01 Primer

The Contractor shall provide primer field samples for quality assurance (QA) testing purposes when specified in the Contract Documents.

The work shall include sampling, labelling, packaging, and delivery of samples to the laboratory designated in the Contract Documents within 5 Business Days.

Each liquid asphalt primer sample shall consist of a one-litre quantity of material. The sample containers for liquid asphalt primer samples shall be new epoxy-lined triple tight cans.

Each emulsified asphalt primer sample shall consist of 2 four-litre quantity of material. The sample containers for emulsified asphalt primer samples shall be new triple tight cans.

Sample containers shall be supplied by the Contractor. Sample labels supplied by the Contract Administrator shall be used to identify all samples.

302.07.02.02 Sand Cover Aggregate

The Contractor shall provide sand cover aggregate samples for QA testing purposes when specified in the Contract Documents.

302.07.03 Demonstration of Primer and Aggregate Application Rates

The Contractor shall demonstrate to the Contract Administrator satisfactory compliance to the specified application rates of primer and aggregate. At the Contract Administrator's option, this compliance may include a minimum 300 m length, one lane width trial section to ensure that the primer and aggregate are applied at the specified rate.

302.07.04 Longitudinal and Transverse Joints

Joints shall be constructed so that granular base is fully covered with primer and the overlap of primer and sand cover is minimal.

302.07.05 Protection of the Work

Traffic shall not be allowed on the primed granular base until the sand cover has been applied. Primed surfaces damaged by traffic shall be repaired by the Contractor.

302.07.06 Surface Preparation

The surface shall be free of standing water. The surface shall be prepared by dampening, fine grading, and compacting and finished rolled using a steel-drum roller to ensure a compacted smooth and float free surface immediately prior to the application of primer.

302.07.07 Application of Primer

Primer application temperatures shall be according to OPSS 1102 and OPSS 1103.

After the surface has been prepared, the primer shall be uniformly sprayed on the granular base at the rate specified in the Contract Documents.

The application of primer shall terminate at the same station for both lanes at the end of each day.

All roadway appurtenances within the area to be surfaced shall be properly covered and protected immediately prior to priming.

302.07.08 Application of Sand Cover

When specified in the Contract Documents, a sand cover shall be applied following the application of primer. A minimum curing time of 20 minutes for the primer shall be provided before sand cover aggregate is applied. Sand cover aggregate shall be uniformly applied by means of a mechanical aggregate spreader at the rate of $11 \pm 1.0 \text{ kg/m}^2$.

Two passes of a pneumatic-tired roller shall be used to seat the aggregate.

302.07.09 Traffic Convoy

When specified in the Contract Documents, the Contractor shall convoy traffic according to OTM, Book 7.

The pilot vehicle shall guide one-way traffic through or around construction. The maximum speed of the convoy shall be 30 km/h. Convoys shall be maintained for a minimum of one hour after application of the sand cover, or longer, if directed by the Contract Administrator.

302.07.10 Management of Excess Material

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

302.08 QUALITY ASSURANCE

When specified in the Contract Documents, testing of the primer shall be conducted by the Contract Administrator, using current LS test methods of the MTO Laboratory Testing Manual or ASTM test procedures as required by OPSS 1102 or 1103.

302.09 MEASUREMENT FOR PAYMENT

302.09.01 Actual Measurement

302.09.01.01 Primer

Primer shall be measured by mass in kilograms as specified in the Contract Documents.

302.09.01.02 Sand Cover Aggregate

Measurement of sand cover shall be by mass or volume as specified in the Contract Documents.

302.09.01.02.01 By Mass

Sand cover aggregate applied to the road shall be measured by mass in tonnes as specified in the Contract Documents.

302.09.01.02.02 By Volume

Sand cover aggregate applied to the road shall be measured by volume in cubic metres, loose, by pre-determined truck capacities. The pre-determined capacity of each truck shall be that computed from its box dimensions.

Loading of each truck shall be to full pre-determined capacity. The Contractor shall not be required to load trucks in excess of this capacity to allow for bulking, and no deduction shall be made for any settlement of the load during transportation, provided that such settlement is not caused by spillage or leakage.

Each truck shall be uniquely and readily identifiable.

302.09.01.03 Traffic Convoy

The measurement for traffic convoy shall be in hours based on the number of hours that the pilot vehicle is convoying traffic.

302.10 BASIS OF PAYMENT

**302.10.01 Primer - Item
 Sand Cover Aggregate - Item
 Traffic Convoy - Item**

Payment at the Contract price for the above items shall be full compensation for all labour, Equipment, and Material to do the work.

Primed surfaces damaged by traffic shall be repaired at no cost to the Owner.

Appendix 302-A, Commentary for OPSS.MUNI 302, November 2016 FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

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

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Rate of application of primer. (302.07.07)

The designer should determine if the following is required and, if so, specify it in the Contract Documents:

- Frequency and type of QA testing required. (302.07.02.01 and 302.07.02.02)
- Location of laboratory for delivery of samples. (302.07.02.01)
- Sand cover. (302.07.08)
- Traffic convoy requirements. (302.07.09)
- Testing of the primer. (302.08)
- Measurement for payment of sand cover aggregate by mass or volume. (302.09.01.02)

Priming of the granular base is required for the application of single surface treatment or one lift of hot mix asphalt.

Sand cover is required when traffic travels on the primed granular base prior to placement of a surface.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here



CONSTRUCTION SPECIFICATION FOR SINGLE AND DOUBLE SURFACE TREATMENT

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304-A	Commentary

304.01 SCOPE

This specification covers the requirements for surface preparation, application of bituminous binder, and application of aggregate for single and double surface treatment.

304.01.01 Significance and Use of Appendices

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

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

332.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

304.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Material

OPSS 1006 Aggregates - Surface Treatment
OPSS 1103 Emulsified Asphalt

Ministry of Transportation Publications

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

304.03 DEFINITIONS

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

Appurtenances mean maintenance hole, catch basin, valve chamber, and water valve covers and similar Utility access covers located within the paved portion on the roadway.

Binder means an emulsified asphalt with or without polymer modification used to bind aggregates.

Double Lap means the coverage produced from the application of binder where the binder from each spray bar nozzle overlaps the binder application from the adjacent nozzle by one half.

Double Surface Treatment means two successive single surface treatments.

End Nozzle means a spray bar nozzle which delivers binder to the inside half of a standard spray pattern.

Lot means the quantity of work completed with a tanker truck shipment of binder.

Single Surface Treatment means a single application of bituminous binder followed by a single application of Class 1, Class 2, Class 3, Class 4, Class 5, or Class 6 aggregate.

Triple Lap means the coverage produced from the application of binder where the binder from each spray bar nozzle overlaps the binder application from the adjacent nozzle by two thirds.

304.05 MATERIALS

304.05.01 Binders

Binders shall be according to OPSS 1103.

304.05.02 Aggregates

Aggregates shall be according to OPSS 1006 and as specified in the Contract Documents.

304.06 EQUIPMENT

304.06.01 Pressure Distributor

The pressure distributor shall be designed and manufactured to spray binder on the road surface. The pressure distributor shall be capable of applying binder at the specified rates and in a continuous and uniform manner both longitudinally and transversely for a full lane width.

304.06.02 Mechanical Aggregate Spreader

The mechanical aggregate spreader shall be designed and manufactured to be self-propelled and capable of continuously and uniformly distributing aggregate at the specified application rate.

304.06.03 Rotary Power Brooms

Brooms shall be capable of cleaning gravel, sand, dirt, and other debris from the roadway surface.

304.06.04 Rollers

304.06.04.01 General

Rollers shall be ballasted according to the manufacturer's recommendations.

304.06.04.02 Steel Drum Rollers

Steel drum rollers shall be single drum vibratory rollers according to Table 1 and shall be operated in the static mode, if the drum is not rubber coated. Drive wheels shall not mark the aggregate.

304.06.04.03 Pneumatic-Tired Rollers

Pneumatic-tired rollers shall be self-propelled and be according to Table 2. The wheels shall be mounted with smooth tread rubber tires. Tire inflation pressure shall be a minimum of 350 kPa when the tires are cold. All

tires shall have equal pressure. Each roller shall be equipped with a suitable tire pressure gauge for checking tire inflation pressure.

304.06.05 Pilot Vehicle

The pilot vehicle shall be equipped according to the requirements of the OTM, Book 7.

304.07 CONSTRUCTION

304.07.01 Operational Constraints

Surface treating operations shall not be carried out when the ambient temperature at the work location is less than 10 °C or where climatic or site conditions preclude the curing of the binder.

The application of binder and aggregate shall terminate one hour before sunset.

Surface treatment shall not be carried out prior to May 15th south of a line through Pembroke, Magnetawan, and Pointe au Baril Station or prior to June 1st north of the line.

Surface treatment shall not be carried out after September 1st except with the approval of the Contract Administrator. Surface treatment may be extended to September 30th provided a high float emulsion is used.

304.07.02 Sampling

304.07.02.01 Binder

The Contractor shall provide binder field samples for testing purposes as specified in the Contract Documents.

The work shall include sampling, labelling, packaging, and delivery of samples to the laboratory designated in the Contract Documents within 5 Business Days.

Each binder sample shall consist of a minimum size of two full 4-litre samples of material. The sample containers for emulsified asphalt binder samples shall be triple tight cans. Sample containers shall be new and supplied by the Contractor.

304.07.02.02 Aggregates

The Contractor shall provide aggregate samples for testing purposes as specified in the Contract Documents.

304.07.03 Determination of Binder and Aggregate Application Rates

The application rate for the binder and the aggregate shall be as specified in the Contract Documents.

The Contractor shall demonstrate to the Contract Administrator satisfactory compliance to the specified application rates of binder and aggregate. At the Contract Administrator's option, this compliance may include a minimum 300 m one lane width trial section to ensure that the binder and aggregate are applied at the specified rate.

304.07.03.01 Acceptance of Binder Application Rate

The binder application rate is acceptable when the rate of application is within a tolerance of $\pm 5\%$ of the specified rate.

304.07.03.02 Acceptance of Aggregate Application Rate

The aggregate application rate is acceptable when the rate of aggregate application is within a tolerance of $\pm 10\%$ of the specified rate.

304.07.04 Surface Preparation

Existing bituminous surfaces shall be clean and free of all debris and standing water before application of binder.

Where a binder is to be applied on a granular surface, the surface shall be free of standing water and shall be prepared by dampening, fine grading, and compacting immediately prior to the application of the binder. The surface shall be finish rolled to ensure a compacted smooth and float free surface.

304.07.05 Binder Application Temperatures

Binder application temperatures shall be according to OPSS 1103.

304.07.06 Application of Binder

After the surface has been prepared, the binder shall be uniformly sprayed on the road surface at the specified application rate. When binder is to be applied to two adjacent lanes, the application of binder on the initial pass shall be done without the use of an end nozzle. When binder is applied to the adjacent lane, the nozzle positioned closest to the first application of binder shall be an end nozzle.

The spray bar height shall be adjusted to ensure that there is triple lap of the binder application. At the written request of the Contractor, the Contract Administrator may allow the use of a double lap application.

Longitudinal joints shall be constructed to ensure full coverage on the centreline.

The application of binder shall terminate at the same station for both lanes at the end of each day.

All roadway appurtenances within the area to be surfaced shall be properly covered and protected immediately prior to single and double surface treatment.

304.07.07 Application of Aggregate

Aggregate shall be uniformly applied at the rate specified. The distance between the pressure distributor and the spreader shall not be more than 30 m.

If excess aggregate is present when constructing a double surface treatment, the excess shall be removed prior to the second application of binder.

304.07.08 Rolling

Immediately after spreading, the aggregate shall be rolled with a minimum of two pneumatic-tired rollers. The entire treated area shall receive two passes from each pneumatic-tired roller.

When the surface treatment is placed on a prepared granular grade, one pneumatic-tired roller shall be replaced by a steel drum roller. The entire treated area shall receive two passes from the pneumatic-tired roller and one pass from the steel drum roller.

Rollers shall be operated at such a speed as to prevent aggregate pick-up, but in no case shall the speed of rollers exceed 10 km/h.

All rolling shall be completed within 300 m of the aggregate spreader. When the combination of rollers is not sufficient to maintain the completed rate of progress, additional rollers shall be used.

304.07.09 Traffic Convoy

When specified in the Contract Documents, the Contractor shall convoy traffic according to the OTM, Book 7.

The pilot vehicle shall guide one-way traffic through or around construction. The maximum speed of the convoy shall be 30 km/h. Convoing shall be maintained until such time as the surface treatment is able to carry traffic without damage.

304.07.10 Protection of the Work

The Contractor shall repair damaged areas until such time as the work has been accepted by the Contract Administrator.

Signs indicating fresh surface treatment, or similar wording, shall be erected at the project limits and any intersections throughout the project immediately after placement of surface treatment and shall remain in place for a minimum of 72 hours.

304.07.11 Management of Excess Material

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

304.09 MEASUREMENT FOR PAYMENT

304.09.01 Actual Measurement

304.09.01.01 Binder

Binder shall be measured for payment by mass in kilograms according to the requirements of the Contract Documents.

304.09.01.02 Class 1, 2, 3, 4, 5 or 6 Aggregate

304.09.01.02.01 By Mass

Aggregate applied to the road shall be measured in tonnes according to the requirements of the Contract Documents.

304.09.01.02.02 By Volume

Measurement shall be by volume in cubic metres, loose, by predetermined truck capacities. The predetermined capacity of each truck shall be that computed from its box dimensions.

Loading of each truck shall be kept to not less than the predetermined capacity. The Contractor shall not be required to load trucks in excess of this capacity to allow for bulking, and no deduction shall be made for any settlement of the load during transportation, provided that such settlement is not caused by spillage or leakage.

Each truck shall be uniquely and readily identifiable.

304.09.01.03 Traffic Convoy

The measurement for traffic convoy shall be in hours based on the number of hours that the pilot vehicle is conveying traffic.

304.10 BASIS OF PAYMENT

304.10.01 Binder "*type*" - Item
Class 1 Aggregate - Item
Class 2 Aggregate - Item
Class 3 Aggregate - Item
Class 4 Aggregate - Item
Class 5 Aggregate - Item
Class 6 Aggregate - Item
Traffic Convoy - Item

Payment at the contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Damaged areas requiring repair prior to the acceptance of the work shall be repaired by the Contractor at no extra cost to the Owner.

TABLE 1
Requirements for Steel Drum Rollers

Minimum Drum Diameter mm	Minimum Drum Width mm	Minimum Static Mass per mm of Drum Width kg
1500	2100	2

TABLE 2
Requirements for Pneumatic-Tired Rollers

Roller Class	Minimum Mass t	Minimum Mass per Tire kg
R1	8	900
R2	18	2500
R3	25	3600

**Appendix 304-A, Commentary for OPSS.MUNI 304, November 2016
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS**

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

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Class of Aggregate required. (304.05.02.01)
- Frequency and type of QA testing required. (304.07.02)
- Location of laboratory for delivery of samples. (304.07.02.01)
- Application rate for the binder and aggregate. (304.07.03)
- Traffic convoy requirements. (304.07.09)

The following applications are available depending on traffic volumes, status of road, and type of road surface:

- Single surface treatment is typically applied to either a primed road, a roadway with a previously applied surface treatment, or a paved road.
- Double surface treatment is typically applied to either a granular base or a primed road.

For design estimating purposes, the following application rates may be used:

Treatment	Aggregate Type	Primer or Binder (Note 1)			Aggregate		
		Grade	Range kg/m ²	Typical kg/m ²	Class	Range kg/m ²	Typical kg/m ²
Prime	Class 4	Primer	1.90+/-	1.9	4	10-12	12
Single Surface Treatment	Class 1	CRS-2 or RS-2	1.65-1.90	1.8	1	14-17	16
	Class 2 (Notes 2, 6)	HF-150S	1.35-1.55	1.45	2	16.5-19	19
	Class 4 (Note 3)	CRS-2, HF-150S	1.20-1.40	1.3	4	8-11	11
	Class 5	CRS-2 or RS-2	1.15-1.45	1.3	5	11-13	13
	Class 6	HFMS-2(ON) or HFMS-2P(ON)	1.50-1.80	1.7	6	16-20	17
Double Surface Treatment	Class 2, Note 6	HF-150S (Note 4)	1.60-1.80	1.65	2	16-18	18
		HF-150S (Note 5)	1.45-1.65	1.5	2	16.5-19	19
	Class 3 & 1	CRS-2, RS-2 (Note 4)	1.60-2.10	1.9	3	15-18	17
		CRS-2, RS-2 (Note 5)	1.40-2.10	1.8	1	12-15	14
	Class 3 & 4	CRS-2, RS-2 (Note 4)	1.60-1.75	1.65	3	15-18	17
		CRS-2, RS-2 (Note 6)	1.05-1.20	1.1	4	6.5-8	8
	Class 3 & 5	CRS-2, RS-2 (Note 4)	1.80-2.00	1.90	3	15-17	17
		CRS-2, RS-2 (Note 5)	1.30-1.50	1.35	5	11-13.5	13
	Class 2 & 6	HFMS-2P(ON) (Note 4)	1.60-1.80	1.65	2	13.5-18	16
		HFMS-2P(ON) (Note 5)	1.50-1.70	1.60	6	15-19	16

Notes:

1. Decrease binder rates towards the lower limit of the range when there is heavy commercial traffic.
2. Class 2 surface treatment may cause dust problems in urban areas.
3. Do not apply to flushed surface treatments, flushed pavements or where low friction values are a concern.
4. Initial application.
5. Second application.
6. The use of Granular A aggregate in a Single or Double Surface Treatment is not recommended.

Appendix 304-A

If a granular grade is planned to be open to traffic for a considerable length of time prior to the surface treatment operation, the designer should consider including an item for surface restoration according to OPSS 301, Restoring Unpaved Roadway Surfaces.

The designer should ensure that the Ontario Provincial Standards General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here



CONSTRUCTION SPECIFICATION FOR GRANULAR SEALING

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305.10	BASIS OF PAYMENT

APPENDICES

305-A	Commentary

305.01	SCOPE

This specification covers the materials and requirements for the work of surface preparation and the supply and application of sealer to granular shoulders, shoulder rounding, and all other designated areas.

305.01.01 Specification Significance and Use

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

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

305.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

305.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 304	Single and Double Surface Treatment
OPSS 501	Compacting

Ontario Provincial Standard Specifications, Materials

OPSS 1010	Aggregates – Base, Subbase, Select Subgrade, and Backfill Material
OPSS 1102	Liquid Asphalt
OPSS 1103	Emulsified Asphalt
OPSS 2510	Tall Oil Pitch Emulsion

Ontario Ministry of Transportation, Publications

MTO Laboratory Testing Manual:

LS-100	Rounding-Off of Test Data and Other Numbers
LS-200	Penetration of Bituminous Materials
LS-202	Method of Test for Kinematic Viscosity of Asphalts
LS-204	Solubility of Bituminous Materials in Trichloroethylene
LS-205	Ductility of Bituminous Materials
LS-216	Determination of Residue by Distillation of Emulsified Asphalts
LS-217	Determination of Oil Portion of Distillate in Emulsified Asphalt Primers
LS-218	Particle Charge of Emulsified Asphalt and Emulsified Asphalt Primers
LS-219	Viscosity of Emulsified Asphalts

LS-221	Settlement and Storage Stability of Emulsified Asphalt
LS-223	Sieve Test for Emulsified Asphalts

ASTM International

D1310-14	Standard Test Method for Flash Point and Fire Point of Liquids by Tag Open-Cup Apparatus
D402/D402M-14	Standard Test Method for Distillation of Cutback Asphalt

305.03 DEFINITIONS

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

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

Quality Assurance means a system or series of activities carried out by the Owner to ensure that Materials received from the Contractor meet the requirements specified in the Contract Documents.

305.05 MATERIALS

Sealers may consist of one or more of the following materials:

- a) Type I-a: RC-30 and MTO primer according to OPSS 1102; or
Type I-b: Emulsified asphalt primer according to OPSS 1103.
- b) Type II: Solvent-free emulsified asphalt according to OPSS 1103.
- c) Type III: Tall oil pitch (TOP) emulsion according to OPSS 2510.

305.06 EQUIPMENT

The pressure distribution system used for sealer application shall be according to OPSS 304 and, when applicable, shall include an attachment for hand spraying.

Rollers shall be steel-drum or pneumatic-tired according to OPSS 304.

305.07 CONSTRUCTION

305.07.01 Operational Constraints

A sealer shall only be applied when:

- a) The ambient temperature is a minimum of 5 °C and rising.
- b) The designated area to be sealed is not frozen.
- c) Precipitation is not occurring or imminent and, for Type III emulsion applications, precipitation has not occurred within the 24 hours prior to application.
- d) The surface is free of standing water.

- e) The wind is not strong enough to cause drifting of sealer spray.
- f) The shoulder is smooth and conforms to the crossfall and grade specified in the Contract Documents.

305.07.02 Surface Preparation

As soon as is practical prior to applying sealer, the granular shoulder shall be rolled with a minimum of two passes. The shoulder rounding surface shall not be rolled.

Granular materials to be sealed with Type I or Type II sealers shall be uniformly dampened immediately prior to applying.

The moisture content of granular materials to be sealed with a Type III sealer shall be according to the manufacturer's recommendations.

305.07.03 Application

The sealer types and the locations where they shall be used are specified elsewhere in the Contract Documents.

Type I-a or Type I-b sealers may be used in any areas where Type I sealers have been specified.

Sealers shall be uniformly applied in all areas using a pressure distribution system.

Sealer application rates and temperatures shall be as specified in Table 1.

Sealers shall be overlapped a minimum of 100 mm onto adjacent paved surfaces.

All other application requirements shall be in accordance with the Manufacturer's recommendations and the application performed to the satisfaction of the Contract Administrator.

305.07.04 Management of Excess Material

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

305.08 QUALITY ASSURANCE

305.08.01 General

The Owner reserves the right to make inspections, take samples, and perform QA tests, at such times and locations as the Owner may consider necessary, in order to ensure that the materials supplied and placed are in accordance with this specification.

305.08.02 Sampling of Sealer for Acceptance

Sealers shall be randomly sampled in lots as specified in Table 2.

If the remaining quantity after completing a lot is less than one-half the quantity for a complete lot, then that quantity shall be added to the previous lot. Otherwise the remaining quantity shall form its own lot.

The Contract Administrator shall randomly-choose one sample of sealer from the designated truck tanker representing each lot.

Duplicate samples shall be taken from a sampling spigot on the transfer line or, if one is not available, from the end of the transfer line. Each sample shall be taken after sufficient material has been drawn from the truck tank to purge the transfer line. Sample containers shall be supplied and filled, leaving sufficient space to allow for expansion.

Sampling requirements shall be as specified below and elsewhere in the Contract Documents.

Sample containers for each portion of each duplicate sample shall be triple tight one-litre cans for Type I-a or Type III sealers or triple tight four-litre pails, or suitable plastic containers of similar capacity that can be closed to prevent any leakage for Type I-b or Type II sealers.

Identification tags, provided by the Contract Administrator, shall be completed and attached to each sample container. All sample containers shall be supplied with appropriate WHMIS labels.

Samples shall be delivered within the required time and to the appropriate laboratory specified by the Owner.

305.08.03 Sealer Quality

305.08.03.01 Acceptance

One portion of each duplicate sample shall be tested for material properties by the QA laboratory according to OPSS 1102 for Type I-a sealers, OPSS 1103 for Type I-b and Type II sealers, and OPSS 2510 for Type III granular sealers, respectively.

Individual test results shall be forwarded to the Contractor as they become available.

A lot of sealer shall be deemed to be acceptable, if all of the test results and other requirements specified in OPSS 1102 for Type I-a sealers, OPSS 1103 for Type I-b and Type II sealers, and OPSS 2510 for Type III granular sealers are respectively met.

A lot of sealer not meeting all of the sealer quality requirements shall be given a payment adjustment, as specified in the clause under Payment Adjustments for Sealers.

The Owner shall be responsible for all costs associated with QA testing for acceptance.

305.08.03.02 Referee Testing

The Contractor may invoke referee testing for one or more tested attributes by submitting a written request to the Contract Administrator, within 2 Business Days following notification that the sealer does not meet the requirements of this specification.

Referee testing shall be carried out as specified below and elsewhere in the Contract Documents.

All referee test results for any lot shall replace the respective QA tests for acceptance of the applicable lot and shall be binding on both the Owner and the Contractor.

If a lot is not accepted at full payment based on the referee test results, then the Contractor shall be responsible for the cost of the referee testing of that lot at the rates specified elsewhere in the Contract Documents. In all other cases, the Owner shall bear the cost of the referee testing of that lot.

305.08.04 Visual Deficiencies

All surfaces deemed visually unacceptable by the Contract Administrator due to uneven application of sealer, surface damage, flushing, bleeding or contamination, shall be repaired to the satisfaction of the Contract Administrator.

305.08.04.01 Repairs

All surfaces deemed unacceptable due to uneven application of sealer shall be repaired.

Deficiencies other than uneven application of sealer shall be repaired by removing all deficient areas of sealed granular material, then replacing it with clean, compacted Granular A meeting the requirements specified in OPSS 1010 and OPSS 501.

All repaired areas shall be resprayed with the same sealer type or a sealer with a lower sealer type number, as originally specified in the Contract Documents.

305.09 MEASUREMENT FOR PAYMENT

305.09.01 Granular Sealing

305.09.01.01 Actual Measurement

Measurement shall be by the area sealed in square metres or by mass in kilograms of sealer used, as specified in the Contract Documents.

305.09.01.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurements shall be based on the units shown in the clause under Actual Measurement.

305.10 BASIS OF PAYMENT

305.10.01 Granular Sealing

305.10.01.01 Granular Sealing - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

Sprayed areas damaged by the Contractor's operations or identified by the Contract Administrator as being inadequately treated shall be repaired and resprayed, at no additional cost to the Owner.

Sprayed areas damaged by others shall be repaired and resprayed and shall be administered as a Change in the Work.

305.10.01.02 Payment Adjustments for Sealers

305.10.01.02.01 General

Payment for any lot of sealer that does not meet all Contract requirements shall be subject to a price adjustment. A calculated price adjustment shall be determined through a system of adjustment points based on the test results for any lot sample, provided the sample remains in a condition suitable for testing.

Adjustment points related to the test results for each test shall be individually rounded to one decimal place according to LS-100.

The total number of adjustment points for the tested sample representing a lot shall be divided by 25 to obtain the payment adjustment, expressed as a percentage for the lot.

A fixed adjustment of 50% of the Contract price shall be made for lots to which at least one of the following conditions apply:

- a) A lot sample has not been received by the QA laboratory within sufficient time for the sample to be tested;
- b) The lot sample contains insufficient material for testing; or
- c) The lot sample does not remain in a condition suitable for testing for 14 Days after sampling (e.g., broken emulsion or foam over during distillation).

305.10.01.02.02 Adjustment Points for Type I-a Sealers

For each lot, the total number of adjustment points shall be equal to the summation of the number of units that each test deviates from the specification limits times the multiplier specified for each particular test in Table 3.

305.10.01.02.03 Adjustment Points for Type I-b and Type II Sealers

For each lot, the total number of adjustment points shall be equal to the summation of the number of units that each test deviates from the specification limits times the multiplier specified for each particular test in Table 4, plus:

- a) 1,000 adjustment points, if the test result for the LS-218, the Particle Charge Test, fails to meet the requirement specified in OPSS 1103; plus
- b) 1,000 adjustment points, if the test result for LS-221, the Storage Stability Test, 24 hour, fails to meet the requirement specified in OPSS 1103.

305.10.01.02.04 Adjustment Points for Type III Sealers

For each lot, the total number of adjustment points shall be equal to 62.5 for every 0.1% less than 8% solids for the sample tested according to the procedure given in OPSS 2510 plus an additional 1000 adjustment points, if the material is determined to be anionic according to the Particle Charge Test, LS-218.

TABLE 1
Application Rates and Temperatures

Type of Sealer	Application Rate (kg/m ²)		Application Temperature
	Hand-Sprayed Areas	Machine-Applied/Other Areas	
I-a	3.4	2.6	30 to 45 °C
I-b	3.4	2.6	At Manufacturer's Recommendations
II			
III	5.5	4.5 (Note 1)	Ambient Temperature (Note 2)

Notes:

- 1) Type III sealers shall be applied in 2 or 3 coats for emulsions with 12% and 8% solids, respectively, to deliver a total of 4.5 kg/m².
- 2) Type III sealers shall not be applied if there is any chance that the ambient temperature will reach 0 °C or below within 24 hours after application.

TABLE 2
Lot Sizes

Tender Quantity in m ² or kg		Lot Size (Maximum)
Sealed Area in m ²	Mass of Sealer Used in kg	
< 500	< 1500	Sampling and Testing at CA's Discretion
500 to 5,000	1,500 to 15,000	One lot
> 5,000 to 10,000	>15,000 to 30,000	5,000 m ² / 15,000 kg
> 10,000 to 50,000	>30,000 to 150,000	10,000 m ² / 30,000 kg
> 50,000	> 150,000	20,000 m ² / 60,000 kg

TABLE 3
Tests, Units, and Multipliers for Type I-a Sealers

Test Method	Test Description	Unit	Multiplier
ASTM D 402	Residue by Distillation to 360 °C	%	200
ASTM D 402	Distillate, as % of Total Distillate to 360 °C		
	to 190 °C	%	10
	to 225 °C	%	10
	to 260 °C	%	10
	to 316 °C	%	10
LS-202	Kinematic Viscosity at 60 °C	mm ² /s	20
Tests on Residue			
LS-200	Residue Penetration at 25 °C	0.1 mm	15
LS-204	Residue Solubility	%	10
LS-205	Residue Ductility at 25 °C	cm	10

TABLE 4
Tests, Units, and Multipliers for Type I-b and Type II Sealers

Test Method	Test Description	Unit	Type I-b Multiplier	Type II Multiplier
LS-216	Residue by Distillation	%	200	200
LS-217	Oil Portion of Distillate, By Volume	%	50	50
LS-219	Viscosity at 50 °C, Less Than Minimum	Saybolt Furol Seconds	30	-
	Viscosity at 50 °C, Greater Than Maximum	Saybolt Furol Seconds	5	-
LS-219	Viscosity at 25 °C, Less Than Minimum	Saybolt Furol Seconds	-	30
	Viscosity at 25 °C, Greater Than Maximum	Saybolt Furol Seconds	-	5
LS-223	Sieve Test	%	-	1000
ASTM D 1310	Flash Point, Open Tag	°C	10	-
Tests on Residue				
LS-200	Residue Penetration at 25 °C	0.1 mm	15	15
LS-204	Residue Solubility	%	10	10
LS-205	Residue Ductility at 25 °C	cm	10	10

WARRANT: Always with this tender item.

Appendix 305-A, November 2016
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

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

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

Sampling requirements shall be as specified below and elsewhere in the Contract Documents.

Security measure shall be implemented for referee sample pick-up and delivery. Contractor should be responsible because of time to delivery and adjustment.

The designer should determine if a particular Sealer Type [I, II or III] should be specified in the Contract Documents (305.05).

The designer may choose the appropriate sealer on the basis of the expected number of years when the shoulder would typically need to be re-sealed as follows:

Sealer Type	Expected # of Years Before Re-Sealing*
I	4
II	3
III**	2

*Note: *The expected years shown below are based on the understanding that the shoulder will only be occasionally subjected to vehicular traffic. Note that all sealers shown below should perform behind guiderails for at least 3 years when they're being applied, in accordance with the manufacturer's requirements.

**Type III should only be selected where there is a minimal risk of the shoulders being subjected to vehicular traffic.

Granular Sealer Type III, should only be applied to aggregates meeting the requirements of Granular A, S, or M.

The designer should ensure that the General Conditions of the Contract and the 100 Series General Specifications are included in the Contract Documents.

- Areas designated for granular sealing. (305.07.03)
- Number of Business Days for the delivery of samples. (305.08.01)
- Name and location of the testing laboratory. (305.08.01)
- Unit of measurement for granular sealer. (305.09.01.01)

Related Ontario Provincial Standard Drawings

OPSD 210.070 Granular Sealing



**CONSTRUCTION SPECIFICATION FOR
UNTREATED GRANULAR SUBBASE, BASE,
SURFACE, SHOULDER, AND STOCKPILING**

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314-A	Commentary

314.01 SCOPE

This specification covers the requirements for the construction of untreated granular subbase, base, roadway surface and shoulder, edge ramping for bituminous pavements, and stockpiling at specified sites.

314.01.01 Specification Significance and Use

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

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 350	Concrete Pavement and Concrete Base
OPSS 501	Compacting

Ontario Provincial Standard Specifications, Material

OPSS 1001	Aggregates - General
OPSS 1010	Aggregates - Base, Subbase, Select Subgrade, and Backfill Material

314.03 DEFINITIONS

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

Construction Grading Report means a tabular report provided by the Contract Administrator that identifies stations, offsets, and elevations for granular surfaces consistent with the design cross-section.

Quality Assurance (QA) means a system or series of activities carried out by the Owner to ensure that materials received from the Contractor meet the specified requirements.

Quality Control (QC) means a system or series of activities carried out by the Contractor to ensure that materials supplied to the Owner meet the specified requirements.

314.05 MATERIALS

314.05.01 Aggregates

Granular material and select subgrade material shall be according to OPSS 1010.

314.07 CONSTRUCTION

314.07.01 Granular Subbase, Base, and Surface

Material shall be kept free from clay and other types of deleterious material. The Contractor's operations shall not disturb underlying work.

Material shall be placed without segregation in uniform layers such that the thickness of the compacted layer is not greater than 150 mm, except as provided under the Modified Layer Compaction Method clause.

Each layer shall be bladed to a smooth surface according to the required cross-section and maintained until placement of a subsequent layer, when applicable.

Prior to closing down operations for the completion of each day's work, the subbase material shall be bladed and compacted and, if necessary, covered with sufficient base material to carry traffic.

The granular base shall be maintained to the tolerances in grade and cross-section and to the specified density until the project is accepted or, if the Contract includes paving, until the surface is paved.

314.07.02 Winter Grading of Granular

All ice and snow shall be removed from all portions of the Work Area. Frozen material shall not be incorporated into the Work. Material shall not be placed over frozen ground, except, at the Contractor's option, a single lift may be placed over frozen ground; in which case, final grading and compaction shall be done after the underlying material has thawed.

314.07.03 Edge Ramping of Bituminous Pavement

A ramp of the specified granular material shall be built along the outside edges of each bituminous pavement construction course. Such ramps shall be at a height level with the pavement course and fall away from its edge at a slope not steeper than 4H:1V. Care shall be taken to prevent any ramping material from being spilled or pushed onto the pavement. Any material that is spilled shall be removed immediately without damage to the pavement and the surface thoroughly cleaned with the use of a power broom or other suitable means.

Prior to paving any section, only sufficient material to construct the ramps shall be placed on the shoulders. No other shoulder material shall be placed until the conditions, as detailed in the Shoulders subsection, have been attained.

Edge ramps shall be completed prior to opening adjacent pavement to traffic.

314.07.04 Shoulders

Granular shouldering material shall be placed and compacted at locations and to the line, grade, and cross-section specified in the Contract Documents.

Before commencing shoulder construction, all debris and deleterious material shall be removed from the shoulder area.

Shouldering operations shall commence as soon as, but not before, the following pavement conditions are met:

a) Bituminous Pavements

Placement of granular material for shouldering operations shall not commence along any section of pavement until 24 hours have elapsed from the time of completion of the final bituminous pavement course in that section. The shouldering operations shall be completed within 24 hours on sections of pavement that are open to traffic. When the pavement is not open to traffic, the shouldering shall be completed before traffic is permitted.

b) Concrete Pavement and Concrete Base

Shouldering operations shall commence according to OPSS 350. Shouldering shall be completed before opening the concrete base or concrete pavement to traffic.

All shoulder construction material shall be conveyed from the transport vehicle onto the shoulder area. End dumping of shoulder construction material directly on to the adjacent pavement surface or directly on to the shoulder shall not be permitted. The material shall be uniformly distributed within the specified shoulder limits without segregation. Grading and shaping operations shall confine all material to within the specified shoulder limits without overspill. Any shoulder construction material deposited, dragged, or inadvertently placed on the pavement surface shall be removed immediately and the pavement surface shall be thoroughly cleaned with the use of a power broom or other suitable means.

Operation of equipment shall not cause any damage to the pavement.

314.07.05 Compaction

314.07.05.01 General

Each layer of material shall be compacted as specified before the next layer is placed.

314.07.05.02 Compaction Requirements

The compaction requirements shall be according to OPSS 501.

314.07.05.03 Modified Layer Compaction Method

At the option of the Contractor, granular material may be placed in layers thicker than permitted under the Granular Subbase, Base, and Surface subsection, subject to the following provisions:

- a) All material shall be placed in uniform layers such that each layer shall have a depth of not more than 300 mm after compaction.
- b) Before placing each material in thicker layers, the Contractor shall prove, in a two lane trial area, the ability of the proposed compaction method to achieve the specified density. The location and extent of the trial area shall be approved by the Contract Administrator. At least 48 hours notice shall be given to the Contract Administrator before any work commences on the trial area. Full details of the proposed placing and compacting system or systems, including the rate of placing, depth of layer, number and type of compaction units, and number of passes shall be given to the Contract Administrator. The areas

designated to evaluate each system shall be of sufficient length to be representative of the proposed method and shall normally be approximately 150 m in length.

- c) When the Contract Administrator, on the basis of test results, approves a system of placing and compacting, the system shall be used for the remainder of the work to which it is applicable, except that:
 - i. Should the Contractor find it necessary at any time to change the system or any part of it, including the source of material or the rate of placing the material, the Contractor shall first obtain approval from the Contract Administrator, who may require a further trial area.
 - ii. If at any time tests show that a previously approved system is no longer producing the specified compaction, the Contractor shall make whatever changes are necessary to satisfy the requirements of this specification.

314.07.06 Tolerances

314.07.06.01 General

The surface of the uppermost layer of granular material shall be bladed, shaped, and compacted to produce the specified grade and cross-section.

In the event of a conflict between meeting horizontal grading tolerances and meeting vertical grading tolerances, the vertical grading tolerance shall take precedence.

314.07.06.02 Granular Courses

The finished granular courses shall not deviate more than 30 mm from the specified grade and cross-section and the surface shall not deviate more than 15 mm at any place as measured in any direction with a 3 m straight edge.

314.07.06.03 Bituminous Courses, Sidewalk, Curb, and Gutter

The finished granular surface shall not deviate more than 30 mm from the specified grade and cross-section, except when the finished bituminous grade is controlled by fixed components such as existing pavements and curbs, in which case the finished granular surface shall not deviate more than 10 mm from the specified grade. Granular surfaces shall not deviate more than 10 mm at any place as measured in any direction with a 3 m straight edge.

314.07.06.04 Concrete Courses, Sidewalk, Curb, and Gutter

The finished granular surface shall not deviate more than 10 mm from the specified grade and cross-section and the surface shall not deviate more than 10 mm at any place as measured in any direction with a 3 m straight edge.

314.07.07 Stockpiling of Granular Material

Stockpiles of granular material shall be constructed according to OPSS 1001 at sites specified in the Contract Documents.

314.07.08 Quality Control

The Contractor shall carry out grade checks on the finished granular surfaces and carry out all QC grade checks required to ensure that the finished granular courses are built to within the specified tolerances for grade and cross-section. QC of granular grading shall be based on surface tolerances of the finished granular

courses, as provided in the Tolerances subsection. The grade shall be certified at the stations and offsets shown in the Construction Grading Report.

314.07.09 Submission of Grade Checks

All grade checks relating to horizontal and vertical grading tolerances, including all non-compliances, shall be submitted to the Contract Administrator within 2 Business Days following completion of the grade. The Contractor shall sign and certify the construction grading report as correct.

When grading templates are available, the Contractor shall sign and certify the template as correct. If no template is available, the Contractor shall complete, sign, and submit form OPSF 314-1 to the Contract Administrator.

314.07.10 Management of Excess Material

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

314.08 QUALITY ASSURANCE

314.08.01 General

The Contract Administrator may conduct random QA grade checks to verify that the grade and cross-section are within the specified tolerances.

314.08.02 Finished Grades Outside Specification

When the finished granular grade or cross-section or both do not meet the acceptance criteria, the granular course shall be brought to grade or cross-section or both within the specified tolerances.

314.08.03 Acceptance

Provided that the Contract Administrator's grade checks are according to those determined by the Contractor, no action shall be taken. If discrepancies between QA and QC grade checks occur, additional QA grade checks may be conducted by the Contract Administrator. If the Contract Administrator chooses not to take QA grade checks, the work shall be accepted on the basis of QC grade checks.

If the finished grade or cross-section or both are not according to the specification, the Contractor shall be required to bring the granular surface to grade or cross-section or both within the specified tolerances and recertify the grade.

314.09 MEASUREMENT FOR PAYMENT

314.09.01 Actual Measurement

**314.09.01.01 Granular A, B Type I, B Type II, B Type III, M, O, and S
Granular A, B Type I, B Type II, B Type III, M, and O Stockpiled
Granular A, B Type I, B Type II, B Type III, M, and O from Stockpile
Select Subgrade Material**

314.09.01.01.01 Tonne

When payment is by the tonne:

- a) When the Contractor supplies Granular A and M composed of air-cooled iron blast-furnace slag or nickel slag, the payment quantities shall be determined by applying the following factors:
 - i. The total measured mass of air-cooled iron blast-furnace slag incorporated into the work shall be multiplied by a factor of 1.116.
 - ii. The total measured mass of nickel slag incorporated into the work shall be multiplied by a factor of 0.85.
- b) When Granular B is composed of slag, the payment quantities shall be determined by comparing the density of the material to the average density of granular material as set by the Owner for that specific area and applying the conversion factors so determined to the weighed tonnes.
- c) When granular material is composed of slag, it is necessary to determine the amount of overrun or underrun. Such overrun and underrun shall be the difference between the tender quantity and the payment quantity as determined by applying the foregoing factors to the weighed tonnes.

314.09.01.01.02 Cubic Metre

When payment is by cubic metre, one of the following methods shall be employed as determined by the Contract Administrator:

a) End Area Method

i. At Source

The volume of material shall be measured at the source in their original location and computed in cubic metres by the method of average end areas.

Cross-sections shall be taken after the source has been cleared, grubbed, and stripped of all unsuitable surface material.

The volume of boulders removed from borrow pits that cannot be accommodated in embankments shall be deducted.

ii. In Place

When the measurement for payment of material in their original location is not possible, the measurement for payment shall be made of material measured in place with no allowance for shrinkage and computed in cubic metres by the method of average end areas.

b) Truck Box Method

Material shall be measured in cubic metres, loose, by predetermined truck box capacities. The predetermined capacity of each truck shall be that computed from its box dimensions.

Each truck shall be uniquely and readily identifiable.

314.09.01.01.03 Square Metre

When payment is by square metre, the area shall be based on that shown in the Contract Documents.

314.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

314.10 BASIS OF PAYMENT

- 314.10.01**
- Granular A - Item**
 - Granular A, Stockpiled - Item**
 - Granular A, from Stockpile - Item**

 - Granular B Type I - Item**
 - Granular B Type I, Stockpiled - Item**
 - Granular B Type I, from Stockpile - Item**

 - Granular B Type II - Item**
 - Granular B Type II, Stockpiled - Item**
 - Granular B Type II, from Stockpile - Item**

 - Granular B Type III - Item**
 - Granular B Type III, Stockpiled - Item**
 - Granular B Type III, from Stockpile - Item**

 - Granular M - Item**
 - Granular M, Stockpiled - Item**
 - Granular M, from Stockpile - Item**

 - Granular O - Item**
 - Granular O, Stockpiled - Item**
 - Granular O, from Stockpile - Item**

 - Granular S - Item**
 - Select Subgrade Material, Compacted - Item**

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

The cost of any additional QA grade checks on the recertified area shall be the responsibility of the Contractor. All grading carried out by the Contractor as a result of QA grade checks to ensure tolerances shall be carried out at no additional charge to the Owner.

Compensation for the cleanup of the stockpile site on completion of the operation, when required, shall be included as part of the granular item cost.

314.10.02 From Stockpile

Compensation for clearing, grubbing, stripping, cleanup of the stockpile site, and for supplying and placing a pad upon which the materials are to be stockpiled shall be included as part of the granular item cost.

CERTIFICATION OF GRADE ELEVATION / CROSSFALL

CONTRACT _____

LOCATION _____

COMPONENTS _____

LOCATION _____

In compliance with the Contract, I hereby certify that the following component of the work has been correctly constructed to the specified line and grade tolerances.

FROM STATION	TO STATION	TYPE OF GRADE	DATE	CERTIFIED BY	
				Print name	Signature

OPSF 314-1

**Appendix 314-A, Commentary for OPSS.MUNI 314, November 2016
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS**

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

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Location, line, grade, and cross-section for granular material. (314.07.04)
- Sites for stockpiles of granular material. (314.07.07)

On projects requiring grading, the designer should provide a Construction Grading Report.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR OPEN GRADED DRAINAGE LAYER

TABLE OF CONTENTS

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320.07	CONSTRUCTION
320.08	QUALITY ASSURANCE
320.09	MEASUREMENT FOR PAYMENT
320.10	BASIS OF PAYMENT

APPENDICES

320-A	Commentary

320.01 SCOPE

This specification covers the requirements for materials, construction, and testing of asphalt cement and Portland cement treated open graded drainage layer.

320.01.01 Specification Significance and Use

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

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

320.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

320.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 310	Hot Mix Asphalt
OPSS 313	Hot Mix Asphalt - End Result
OPSS 350	Concrete Pavement and Concrete Base

Ontario Provincial Standard Specifications, Material

OPSS 1003	Aggregates - Hot Mix Asphalt
OPSS 1103	Emulsified Asphalt
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

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-627	Open-Graded Drainage Layer (OGDL) Core Porosity Test

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 material used to delineate 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 drainage layer, subdrains, and the lateral outlets.

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 Contract Administrator shall be provided with the following data at least 14 Days prior to placement of the OGDL:

- a) Aggregate source.
- b) From a laboratory meeting the requirements of the Laboratory Requirements clause:
 - i. Aggregate test results for the required physical properties.
 - ii. Test results for aggregate gradation.
- c) Volumetric proportions for the OGDL mixture.
- d) The type of plant to be used for OGDL mixture production, including the plant location for the Contract.
- e) The method of delineation to be used.

320.04.01.01 Laboratory Requirements

An acceptable laboratory to conduct tests for aggregate physical properties shall be one that holds a current certificate from the Canadian Council of Independent Laboratories (CCIL) as Type D for the applicable test methods and also participates in the annual MTO Proficiency Sample Testing Program for the specific tests.

An acceptable laboratory, to conduct tests for aggregate gradation according to LS-602 and materials finer than 75 µm by washing of the aggregates according to LS-601, shall be one that holds a current certificate from CCIL as Type C. Testing for LS-602 and LS-601 shall be conducted by qualified laboratory staff who hold a valid certificate from CCIL in aggregate testing.

Equivalent alternate laboratory and technician certifications or laboratory proficiency sample testing programs may be used to demonstrate similar requirements to those requested below provided they are acceptable to the Owner.

320.05 MATERIALS

320.05.01 General

Materials for the mixture shall be according to OPSS 313 or OPSS 350, except as amended by the following.

320.05.02 Aggregates

Aggregate for the mixture shall consist of 100% crushed particles produced by crushing bedrock material. Reclaimed materials or crushed reclaimed materials shall not be used.

Physical property requirements shall be according to the requirements for Superpave 19.0 binder course shown in Table 4 of OPSS 1003, except that Note 2 in Table 4 shall not apply. The gradation requirements shall be as shown in Table 1.

320.05.03 Asphalt Cement Treated OGD L

Asphalt cement shall be according to the requirements for performance graded asphalt cement specified in the Contract Documents. The delivery, handling, and storage of asphalt cement shall be according to the manufacturer's requirements. The percentage by mass of asphalt cement in the mixture shall be $1.8 \pm 0.2\%$. The mix shall be prepared according to the requirements of OPSS 1151. Porosity of OGD L shall be 0.25 to 0.50, determined according to LS-627.

320.05.04 Portland Cement Treated OGD L

Portland cement including the delivery, handling, and storage shall be according to OPSS 1301. The mixture shall meet the following requirements:

- a) The cementing material shall be Type 10 Portland cement. No supplementary cementing materials shall be included in the mix.
- b) The mix shall be produced with a water to cement ratio of 0.37 ± 0.01 .
- c) The mix shall contain $120 \pm 10 \text{ kg/m}^3$ of Portland cement.
- d) Water shall be according to OPSS 1302.

Porosity of OGD L shall be 0.25 to 0.50, determined according to LS-627.

320.05.05 Delineator

The delineator shall consist of undiluted SS-1 emulsified asphalt according to OPSS 1103 diluted with an equal volume of water.

320.06 EQUIPMENT

320.06.01 Production Equipment

320.06.01.01 Asphalt Cement Treated OGDL

The mix shall be produced using equipment according to the requirements of OPSS 1150.

320.06.01.02 Portland Cement Treated OGDL

The production of the OGDL mixture shall be completed using a central mixing plant or dry batch plant according to OPSS 1350 and capable of accurately proportioning aggregate, Portland cement, and water.

320.06.02 Paving Equipment

320.06.02.01 Asphalt Cement Treated OGDL

Paving equipment shall be according to OPSS 310.

320.06.02.02 Portland Cement Treated OGDL

Placing equipment shall be according to OPSS 313 or OPSS 350. Placing equipment used shall employ adequate mixing equipment to ensure a homogenous material is placed uniformly across the lane to the required grade and design lift thickness specified in the Contract Documents.

320.06.03 Rollers

Class S rollers shall be according to OPSS 310, except as amended by the following requirements:

- a) The drum widths of the tandem roller shall each be between 1.9 and 2.4 m.
- b) The front drum width of the three-wheel roller shall be between 1.9 and 2.4 m.
- c) Rollers shall have a mass of between 9 and 11 tonnes.

320.06.04 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.

320.07 CONSTRUCTION

320.07.01 Operational Constraints

OGDL mixture shall not be placed in the rain. Precautions shall be taken to protect plastic Portland cement treated OGDL from rain.

Portland cement treated OGDL mixture shall be allowed to cure until the OGDL has gained sufficient strength to support the paving equipment and for a minimum of 48 hours prior to placing the overlying pavement. Protection shall be provided during the curing period.

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 tracking, spilling, or placing of mud or other contaminants onto the OGDL shall not be permitted.

All OGDL shall be covered with the overlying pavement within 30 Days following placement.

The drainage system shall be operational prior to the placement of the OGDL.

320.07.02 Portland Cement Treated OGDL Trial Section

The work required for construction shall be according to OPSS 313, except as amended by the following:

The ability to successfully mix, handle, place, and compact Portland cement treated OGDL mixture shall be demonstrated in the presence of the Contract Administrator prior to placing OGDL mixture. The method of delineation to be used shall also be demonstrated, within the trial section.

A 100 m long trial section consisting of one or two full paving lane widths shall be constructed. Only the material, equipment, and methodology used and approved in the trial section shall be used in the Contract. The location of the trial section shall be proposed by the Contractor. Permission to place the trial section in the proposed location shall be granted or denied by the Contract Administrator. A minimum of 48 hours notice shall be given to the Contract Administrator prior to placing the trial section.

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 Portland cement treated OGDL mixture with the same aggregate source and mixture proportioning, equipment, placing crew, and methodology to meet the Contract requirements for placing Portland cement treated OGDL mixture on a Contract within the last 8 months.

Provided the OGDL trial section meets the requirements of this specification, the trial section shall be considered acceptable. Otherwise, additional trial sections shall be repeated until the OGDL meets the requirements of this specification. A maximum of two trial sections shall be permitted within the Contract limits. Any additional trial sections are to be placed outside the Contract limits.

The trial section shall be divided into four equal sections along its length. A minimum of 2 Days after placing the OGDL, one full depth intact 150 mm nominal diameter core shall be taken at a random location selected by the Contract Administrator from each of the four sections in the trial section.

Core samples shall be inspected by the Contract Administrator and may be tested at the discretion of the Contract Administrator to evaluate the trial for consistency, thickness, and porosity of OGDL.

Permission to place the OGDL mixture shall be granted or denied by the Contract Administrator within 3 Business Days of receipt of trial section cores by the designated laboratory.

320.07.03 Quality Control

320.07.03.01 Sampling and Testing of Aggregate

The Contractor shall be responsible for all quality control (QC) sampling and testing to ensure that the aggregate incorporated into the OGDL meets the physical property and the gradation requirements of the Aggregates subsection. Testing shall be carried out by a laboratory that meets the requirements of the Laboratory Requirements clause.

Testing demonstrating conformance of the aggregates with the aggregate gradation requirements shall be conducted at a frequency chosen by the Contractor.

Testing demonstrating conformance of the aggregates with the physical property requirements shall be completed for each quantity of material produced according to the following schedule:

- a) For the first 20,000 tonnes produced.
- b) For the next 20,000 tonnes produced.
- c) For each 40,000 tonnes produced thereafter.

Further testing is required whenever material is produced from 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.

For Portland cement treated OGDL, the Contractor shall maintain the correct water cement ratio by monitoring the aggregate moisture content during mix production. These monitoring records shall be available to the Contract Administrator upon request.

320.07.04 Longitudinal and Transverse Joints

Longitudinal and transverse joints shall be according to OPSS 313, except that painting of joints is not required.

320.07.05 Rolling

Only static rollers or vibratory rollers in the static mode shall be used. Compaction shall consist of three to five passes of a Class S roller, irrespective of the production rate. Compaction of the Portland cement treated OGDL shall be carried out immediately after placement.

Aggregate pick-up by the rollers shall be minimized. 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.

320.07.06 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 is to be such that when tested with a straight edge placed in any direction on the surface, there shall not be a gap greater than 5 mm between the bottom of the straight edge and the surface of the OGDL. Grading or milling, or both, of the finished surface shall not be permitted.

320.07.07 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 at a rate of 0.35 kg/m² in a continuous and uniform manner over all of the OGDL to be overlaid. The distributors shall be equipped with a volume metering device of sufficient sensitivity to measure the quantity of delineator dispensed in litres.

320.07.08 Sampling

320.07.08.01 Core Sampling

Prior to the placement of the overlying pavement layer, one intact 150 mm nominal diameter core shall be taken for the full depth of the OGDL at a random location selected by the Contract Administrator from each subplot. Cores shall be taken in a manner to avoid sample damage. If an intact and undamaged core cannot be obtained, the sample can 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 saw cut sample must be intact and undamaged.

320.07.08.02 Labelling

The Contract Administrator is to be advised when each sample is to be taken and the Contract Administrator shall apply security seals to samples taken for quality assurance (QA) testing. Samples shall be placed in a suitable container to protect the sample integrity and shape during transportation and until testing. Each sample shall be labelled with the sample identification number, Contract number, station location, and offset from the centreline of the roadway. The sample identification numbers shall be specified by the Contract Administrator.

320.07.08.03 Delivery

The samples shall be delivered to a laboratory designated by the Contract Administrator within 24 hours of sampling. These samples shall be transported in a manner that avoids damage to the samples.

320.07.08.04 Repair of Sampling Locations

Immediately after sampling, each sample hole shall be filled with OGDL aggregate up to the top of the surrounding OGDL.

320.07.09 Management of Excess Material

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

320.08 QUALITY ASSURANCE

320.08.01 General

QA testing shall determine the thickness and porosity of OGDL samples. QA testing shall be carried out by the Contract Administrator for purposes of ensuring that material placed in the work is according to the requirements of this specification. The Contract Administrator shall be allowed access to all sampling locations and reserves the right to request a QA sample at any time. The QA test results shall be provided to the Contractor within 24 hours of receipt of the test results by the Contract Administrator.

320.08.02 Acceptance

Acceptance of the OGDL is based on surface appearance, surface tolerance, thickness, and porosity.

320.08.02.01 Acceptance of Surface Appearance

Surface appearance shall be assessed by the Contract Administrator based on visual surveys. The finished OGDL surface shall have a uniformly open texture and be free from loose aggregates. The OGDL is rejectable if over a 100 m² section:

- a) a single appearance irregularity exceeds 1 m², or
- b) the combined area of multiple irregularities exceeds 2 m².

OGDL that is rejected for appearances shall be repaired. OGDL that is repaired shall be re-decisioned according to the Repairing and Re-Decisioning subsection.

320.08.02.02 Acceptance of Surface Tolerance

The surface tolerance of any OGDL surface shall be such that when tested with a straight edge placed anywhere on the OGDL surface, including the edge of the OGDL, in any direction on the surface, except across the crown, there shall not be a gap between the bottom of the straight edge and the surface of the OGDL greater than 5 mm. All areas not meeting the surface tolerance requirements shall be repaired and decisioned according to the Repairing and Re-Decisioning subsection.

320.08.02.03 Acceptance of Thickness

The Contract Administrator shall test one sample from each subplot to determine the thickness of the OGDL in accordance with ASTM C 174/C 174M. The QA laboratory shall report thickness test results within 3 Working Days of receipt of the samples. 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.

Thickness acceptance is based on the mean of the lot, provided no single subplot is deemed rejectable. A subplot is rejectable if the subplot thickness is less than 0.60 of the design lift thickness.

If the lot mean thickness is equal to or greater than the design lift thickness less 5.0 mm, the item shall be accepted without any price reduction for thickness.

If the lot mean thickness is less than the design lift thickness less 5.0 mm, but greater than or equal to 0.60 of the design lift thickness, the lot shall be subject to price reduction. The material shall be accepted provided the Contractor accepts a price reduction for thickness calculated using the pay factors shown in Table 2.

The lot is rejectable if the lot mean thickness is less than 0.60 of the design lift thickness.

The Contract Administrator shall determine if a rejectable subplot may remain in the work without repairs. If a lot is rejectable, the rejectable sublots shall be repaired. If a lot is classified as acceptable or for price reduction, the Contract Administrator may determine that a rejectable subplot can remain in the work without repair with the lot subjected to a price reduction. If the Contractor elects to repair the subplot in lieu of a price reduction or if the Contract Administrator determines that a rejectable subplot requires repair, the subplot shall be repaired and decisioned according to the Repairing and Re-Decisioning subsection.

320.08.02.04 Acceptance of Porosity

The QA laboratory shall test one sample from each subplot to determine the porosity of OGDL calculated to three decimal places according to LS-100. The test results for each subplot shall be used to compute the lot mean for porosity of OGDL.

The QA laboratory shall report to the Contract Administrator the porosity of OGDL test results within 14 Days of receipt of the samples.

Porosity of OGDL acceptance is based on the mean porosity of OGDL of the lot calculated to two decimal places according to LS-100, provided no single subplot is deemed rejectable. A subplot is rejectable if the porosity of OGDL is less than 0.200 or greater than 0.550.

If the lot mean porosity of OGDL is equal to or greater than 0.25 but less than 0.50, the item shall be accepted without any price reduction for porosity of OGDL.

If the lot mean porosity of OGDL is less than 0.25 and greater than or equal to 0.20 or is from 0.50 to 0.55, the lot shall be subject to a price reduction. The material shall be accepted provided the Contractor accepts a price reduction for porosity of OGDL calculated using the pay factors shown in Table 3.

The Contract Administrator shall determine if a rejectable subplot may remain in the work without repairs. If a lot is rejectable, the rejectable sublots shall be repaired. The lot is rejectable if the lot mean porosity of OGDL is less than 0.20 or greater than 0.55. When the Contract Administrator has determined that a rejectable subplot may remain in the work without repair, the lot shall be subjected to a payment adjustment. If the Contractor elects to repair the subplot in lieu of a payment adjustment or if the Contract Administrator determines that a rejectable subplot requires repair, the subplot shall be repaired and decisioned according to the Repairing and Re-Decisioning subsection.

320.08.03 Lot Size

After discussions with the Contractor and prior to the placement of the OGDL, the Contract Administrator shall establish the lot size and the number of sublots with a maximum subplot size of 4,000 m².

320.08.04 Repairing and Re-Decisioning

320.08.04.01 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.

Any OGDL identified by the Contract Administrator as contaminated shall be deemed rejectable and shall be repaired as specified herein.

320.08.04.02 Surface Appearance

Rejectable OGDL due to surface irregularities or contamination shall be removed and replaced.

320.08.04.03 Surface Tolerance

Where surface tolerances are exceeded, the deficiencies shall be corrected with an additional thickness of overlying surface material.

320.08.04.04 Thickness and Porosity

For each subplot that is rejectable due to thickness or porosity or both, the Contractor shall determine the limits of the rejectable OGDL based on additional sampling and testing.

For the rejectable subplot, the areas proposed to be retained by the Contractor shall comprise a new lot of OGDL for acceptance purposes. The number of sublots in the new lot shall be determined by the Contract Administrator. The unrepaired OGDL shall be decisioned in accordance with the Acceptance of Thickness clause or the Acceptance of Porosity clause or both, as appropriate.

New OGDL placed for repairs shall constitute a new lot of OGDL for acceptance purposes with sublots as follows:

- a) 1 sublot for up to 100 m² of repairs.
- b) 2 sublots for up to 500 m² of repairs.
- c) 3 sublots for greater than 500 m² of repairs.

The maximum lot size for new OGDL used for repairs shall be 2,000 m².

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.

Unacceptable trials, including trial mix, placement, removal, disposal, and testing, shall be at no extra cost to the Owner. Trials outside the Contract limits shall be at no additional cost to the Owner.

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 Contractor is not required to or does not elect to repair the lot, the payment reduction for the lot shall be as follows.

$$(2.000 - PF_T - PF_P) \times \text{item price} \times \text{lot quantity}$$

For purposes of payment reduction, the term item price means the Contract price of the applicable tender item.

TABLE 1
Gradation Requirements (LS-602)

Percentage Passing By Dry Mass of Aggregate								
Sieve Designation								
37.5 mm	26.5 mm	19.0 mm	16.0 mm	13.2 mm	9.5 mm	4.75 mm	2.36 mm	75 µm
100	95 - 100	90 - 100	65 - 100	40 - 86	20 - 55	0 - 10	0 - 5	0 - 2

TABLE 2
Thickness Payment Factors

Acceptance Criteria	Classification	Payment Factor, PF_T
$T_C \geq T_D - 5.0 \text{ mm}$	Acceptable	1.000
$T_D - 10.0 \text{ mm} \leq T_C < T_D - 5.0 \text{ mm}$	Payment Reduction	$(5.0 + T_C)/T_D$
$0.60T_D \leq T_C < T_D - 10.0 \text{ mm}$	Payment Reduction	$(10.0 + 1.5T_C)/T_D - 0.50$
$T_C < 0.60T_D$	Rejectable	$(10.0 + 1.5T_C)/T_D - 0.50$

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 3
Porosity of OGDL Payment Factors

Acceptance Criteria	Classification	Payment Factor, PF_P
$0.25 \leq n_C < 0.50$	Acceptable	1.000
$0.20 \leq n_C < 0.25$	Payment Reduction	$1 - 4(0.25 - n_C)$
$0.50 \leq n_C \leq 0.55$	Payment Reduction	$1 - 4(n_C - 0.50)$
$n_C < 0.20$	Rejectable	$1 - 4(0.25 - n_C)$
$n_C > 0.55$	Rejectable	$1 - 4(n_C - 0.50)$

Where: PF_P is the payment factor for porosity of OGDL of the lot calculated to three decimal places according to LS-100.
 n_C is the mean porosity of OGDL of the lot calculated to two decimal places according to LS-100.

Appendix 320-A, November 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

Open Graded Drainage Layer (OGDL) is a premium pavement drainage layer that has the same structural equivalency as crushed granular base, but is designed to drain off any infiltrated surface water before it saturates the pavement structure. OGDL is recommended for use on major arterials and expressways with rigid and flexible pavements.

The designer should specify the following in the Contract Documents:

- The requirements for performance graded asphalt cement. (320.05.03)
- OGDL design lift thickness. (320.06.02.02)
- The required grade and cross-section. (320.07.06)

A minimum compacted thickness of 100 mm placed in a single lift is recommended for OGDL.

A minimum 100 mm thick layer of compacted Granular A as a filter layer should be placed under the OGDL to prevent migration of fines upward into the OGDL.

For flexible pavements, a minimum thickness of 160 mm of hot mix is recommended.

OGDL should be part of a high performance drainage system as detailed in the related Ontario Provincial Standard drawings.

For superelevated sections, it is necessary to have a collector drain only at the lower edge of pavement.

The drainage system including subdrain backfill, geotextile, and outlets should be constructed according to OPSS 405.

For inaccessible areas where conventional paving equipment cannot be used, (e.g., tapers and narrow widenings) the designer should consider specifying an alternate free draining base material such as Granular O, OGDL aggregate, or hand placed OGDL.

This is an end result type specification with payment adjustments for mean porosity and mean thickness. This specification allows the Contractor to choose asphalt cement treated or Portland cement treated OGDL, and includes requirements for Contractor quality control.

Specific clauses within the specification apply to either the asphalt cement treated or Portland cement treated OGDL.

Since the OGDL Porosity Test is a non-routine test, there are a limited number of laboratories capable of carrying out this test.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 207.041	Open Graded Drainage Layer with Subdrain Pipe, Paved Shoulders
OPSD 207.044	Subdrain Pipe Connections and Outlets, for Open Graded Drainage Layer



**CONSTRUCTION SPECIFICATION FOR
IN-PLACE FULL DEPTH RECLAMATION OF BITUMINOUS PAVEMENT
AND UNDERLYING GRANULAR**

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330-A	Commentary

330.01	SCOPE

This specification covers the requirements for in-place full depth reclamation of bituminous pavement and mixing with a portion of the underlying granular, and shaping and compacting the processed materials as granular base.

330.01.01 Specification Significance and Use

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

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

330.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

330.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 301	Restoring Unpaved Roadway Surfaces
OPSS 501	Compacting

Ontario Ministry of Transportation Publications

MTO Laboratory Testing Manual:	
LS-621	Determination of Amount of Asphalt-Coated Particles in Coarse Aggregate

330.07 CONSTRUCTION

330.07.01 General

The work of in-place full depth reclamation shall consist of pulverizing the existing bituminous pavement, mixing the processed material with the underlying granular material, and shaping and compacting the blended material and the existing shoulders.

330.07.02 Operational Constraints

The in-place full depth reclamation including pulverizing, mixing, shaping, and compacting to final grade shall be completed across the full pavement width prior to closing down operations each day.

The existing shoulders shall also be shaped and compacted to grade prior to closing down operations each day.

330.07.03 Reclamation of Bituminous Pavement and Underlying Granular

The bituminous pavement and underlying granular shall be reclaimed to the depths specified in the Contract Documents. The tolerance for the average depth of processing shall be ± 15 mm from the depth specified.

The processed depth shall be such that the blended material shall contain a maximum of 50% by mass of asphalt coated aggregate in the final blend as determined by LS-621.

The operation of full-depth reclamation shall ensure that 100% of the mixed material by mass passes the 50 mm sieve and 95% passes the 37.5 mm sieve.

330.07.04 Surface Shaping and Compacting

The graded surface of the processed material, including existing shoulder, shall be according to the requirements of OPSS 301. The material shall be compacted as specified in OPSS 501. Scarifying and fine grading to the specified lines and grades shall be carried out immediately prior to paving.

330.07.05 Management of Excess Material

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

330.08 QUALITY ASSURANCE

330.08.01 Samples for Testing

Samples for testing may be taken by the Contract Administrator to ensure that the mix is according to LS-621.

330.09 MEASUREMENT FOR PAYMENT

330.09.01 Actual Measurement

330.09.01.01 In-Place Full Depth Reclamation of Bituminous Pavement and Underlying Granular

Measurement of in-place full depth reclamation of bituminous pavement and underlying granular shall be by horizontal area processed in square metres.

330.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

330.10

BASIS OF PAYMENT

330.10.01

In-Place Full Depth Reclamation of Bituminous Pavement and Underlying Granular - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

Appendix 330-A, November 2014
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

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

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Reclamation depth of bituminous pavement and underlying granular. (330.07.03)

When additional granular base material is specified, it should be placed prior to the full depth reclamation and incorporated into the processed material.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR FULL DEPTH RECLAMATION WITH EXPANDED ASPHALT STABILIZATION

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331-A	Commentary

331.01 SCOPE

This specification covers the requirements for in-place full-depth reclamation of the existing hot mix asphalt (HMA) pavement and underlying granular base; shaping and compacting the unstabilized material; adding and blending corrective aggregate or active filler or both, if required; adding and mixing expanded asphalt; and shaping and compacting the expanded asphalt mix.

331.01.01 Specification Significance and Use

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

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

331.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

331.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 301	Restoring Unpaved Roadway Surfaces
OPSS 310	Hot Mix Asphalt
OPSS 501	Compacting

Ontario Provincial Standard Specifications, Material

OPSS 1010	Aggregates - Base, Subbase, Select Subgrade, and Backfill Material
OPSS 1101	Performance Graded Asphalt Cement
OPSS 1301	Cementing Materials

Ontario Ministry of Transportation Publications

SP-027	Manual for Assessment of Surface Defects of In-Place Recycled Pavement Mats

MTO Laboratory Testing Manual:

LS-200	Penetration of Bituminous Materials
LS-282	Quantitative Extraction of Asphalt Cement and Analysis of Extracted Aggregate from Bituminous Paving Mixtures
LS-292	Quantitative Determination of Asphalt Cement Content by Ignition and Analysis of Remaining Aggregate from Bituminous Paving Mixtures
LS-297	Determination of Indirect Tensile Strength of Expanded Asphalt Mixes
LS-625	Sampling of Granular Materials

Wirtgen GmbH Publication

Wirtgen Cold Recycling Technology manual, 3rd edition, 2010

331.03 DEFINITIONS

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

Active Filler means substances added to the reclaimed materials that chemically alter the mix properties.

AMRL means as defined in OPSS 310.

CCIL means as defined in OPSS 310.

Corrective Aggregate means virgin aggregate or reclaimed asphalt pavement (RAP) or both added to the reclaimed materials to meet the expanded asphalt mix requirements.

Expanded Asphalt means heated asphalt cement expanded from its normal volume by the addition of water.

Expanded Asphalt Mix (EAM) means the mixture of reclaimed materials; corrective aggregate or active filler or both, if required; and expanded asphalt.

Performance Graded Asphalt Cement (PGAC) means as defined in OPSS 310.

Quality Assurance (QA) means as defined in OPSS 310.

Quality Control (QC) means as defined in OPSS 310.

Reclaimed Asphalt Pavement (RAP) means as defined in OPSS 310.

Unstabilized Material means the mixture of reclaimed existing asphalt pavement and granular base and corrective aggregate or active filler or both, if required.

331.04 DESIGN AND SUBMISSION REQUIREMENTS

331.04.01 Design Requirements

For mix design purposes, prior to commencing the work the Contractor shall obtain samples representative of the material that is produced during in-place full-depth reclamation. These samples shall be used to establish the design rate of expanded asphalt as a per cent by mass of the unstabilized material. The design rate of the expanded asphalt shall be a minimum of 2.8%. The dry tensile strength shall be a minimum of 225 kPa and the wet tensile strength shall be a minimum of 100 kPa. The tensile strength ratio shall be a minimum of 50%.

The mix design shall be carried out according to the Wirtgen Cold Recycling Technology manual using briquettes produced according to LS-297. Mix design work shall be completed by a laboratory with CCIL Type A certification or equivalent equipped to carry out expanded asphalt mix design. When the existing pavement significantly changes composition, a separate mix design shall be completed.

Each mix design shall include the following

- a) Information on the grade, manufacturer, and supplier of the PGAC.
- b) The per cent by mass of expanded asphalt in the mix, referred to as the design rate, and all calculations performed to determine the design rate of the expanded asphalt.
- c) The recommended PGAC temperature for foaming, the half life, the expansion ratio, and the per cent water added for foaming.
- d) The optimum moisture content and the mix design bulk relative density.
- e) The dry tensile strength, the wet tensile strength, and the tensile strength ratio.
- f) The amount of water to be added to the mix.
- g) Maximum field rate adjustment allowed to the design rate without adverse affects to mix properties.
- h) Recovered penetration for the binder of the existing pavement according to LS-200.
- i) Type, source, gradation, and quantity of corrective aggregate, if required.
- j) Type, source, and quantity of active filler, if required.

331.04.02 Submission Requirements

The mix design shall be submitted by the Contractor to the Contract Administrator a minimum of 7 Business Days prior to the start of the reclamation and stabilization. When more than one mix design is required, the area for which each mix design is to be used shall be clearly identified.

A new mix design shall be submitted when the expanded asphalt design rate is adjusted by 0.3% or greater. Separate or new mix designs shall be submitted if the composition or layer thicknesses or both of the existing pavement changes significantly.

331.05 MATERIALS

331.05.01 Active Filler

If required by the mix design, active filler shall be incorporated into the reclaimed material at the application rate determined in the mix design.

When used as active filler, Portland cement shall be according to OPSS 1301. No more than one per cent by mass of Portland cement shall be added to the mix.

331.05.02 Corrective Aggregate

If required by the mix design, corrective aggregate shall be incorporated into the reclaimed material at the application rate determined in the mix design. Corrective aggregate shall meet the physical property requirements of OPSS 1010 for Granular A.

331.05.03 Performance Graded Asphalt Cement

The Contractor shall select a PGAC with suitable expansion characteristics. PGAC shall be according to OPSS 1101, excluding the PGAC zone requirements.

331.05.04 Reclaimed Asphalt Pavement

RAP material shall be 100% passing the 37.5 mm sieve and 95 to 100% passing the 26.5 mm sieve after processing.

331.05.05 Water

Water shall be clean and free from oil, acid, alkali, organic matter, or other deleterious substances.

331.06 EQUIPMENT

331.06.01 Full-Depth Reclamation and Stabilization Equipment

The reclaimer-stabilizer shall be capable of reclaiming the existing asphalt pavement and underlying granular base to the depths specified in the Contract Documents, incorporating corrective aggregate or active filler or both into the mix, adding expanded asphalt in a controlled manner, and producing a uniform mix.

The reclaimer-stabilizer shall be fitted with an automatic sensor system to accurately maintain a preset depth of cut within a tolerance of 10 mm and shall have a minimum 2.0 m wide cutting drum.

The reclaimer-stabilizer shall have an asphalt cement expansion system capable of producing optimum expansion and an injection system capable of injecting and blending expanded asphalt uniformly throughout the unstabilized material. In order to mix the unstabilized material with the expanded asphalt, the reclaimer-stabilizer shall include the following features:

- a) A system to control and regulate the application of expanded asphalt in relation to travel speed and mass of material within a tolerance of $\pm 3.0\%$ by volume of asphalt cement.
- b) A system to monitor and control all aspects of the mixing process, including per cent expanded asphalt, rate of application, and per cent water for optimum compaction.
- c) A system of nozzles that provides uniform application of the expanded asphalt across the full width of treatment. The application system shall be adjustable for varying widths of treatment.

The aggregate delivery vehicle shall have a system for controlled application of the corrective aggregate.

Alternative equipment may be considered subject to approval by the Contract Administrator and demonstration of meeting the requirements of the Expanded Asphalt Trial Section subsection.

331.06.02 Placing Equipment

Placing of the expanded asphalt mix shall be carried out by means of a self-propelled mechanical paver capable of spreading the mix evenly in front of the screed in one continuous pass to the specified cross-fall and grade. The paver shall be equipped with distributing augers for the full width to be paved. The paver shall have a vibratory screed capable of vibrating the full width of mix placed.

331.06.03 Pilot Vehicle

The pilot vehicle shall be according to the requirements of the OTM, Book 7.

331.07 CONSTRUCTION

331.07.01 Operational Constraints

In-place full depth reclamation, including mixing, shaping, and compacting to final grade, shall be completed across the full pavement width prior to closing down operations each day.

The existing shoulders shall be shaped and compacted to match the adjacent lane prior to closing down operations each day.

Expanded asphalt stabilization shall not proceed during periods of rain or when the surface is in a saturated condition.

Traffic, including construction traffic, shall be kept off the freshly placed EAM until such time as it is able to carry traffic without damage. The Contractor shall be responsible for repair of damaged EAM.

The wearing surface shall not be placed on the EAM until the following requirements have been met:

- a) The EAM has been allowed to cure for a minimum of 2 Days.
- b) The Contractor has demonstrated that the EAM meets all the requirements of this specification.
- c) All defective areas in the EAM have been repaired to the satisfaction of the Contract Administrator.

331.07.02 In-Place Full-Depth Reclamation

The existing asphalt pavement and underlying granular base shall be reclaimed to the depths and widths specified in the Contract Documents.

The graded surface of the reclaimed material, including existing shoulders, shall be according to the surface tolerance requirements of OPSS 301. Reclaimed material exceeding 50 mm in size shall be removed from the work. The material shall be compacted according to OPSS 501.

331.07.03 Expanded Asphalt Trial Section

Prior to carrying out expanded asphalt stabilization on the Contract, the Contractor shall demonstrate to the Contract Administrator the ability to successfully carry out expanded asphalt stabilization according to this specification by placing a trial section within the Contract limits.

In lieu of a trial section, the Contract Administrator may accept evidence that the Contractor has demonstrated the ability to successfully mix, handle, place, and compact EAM with the same equipment, placing crew, and methodology to meet the Contract requirements for placing EAM on any Contract within the last 12 months.

The trial section shall be a minimum of 3,500 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. The Contractor shall give the Contract Administrator a minimum of 48 hours notice prior to placing the trial section.

The Contract Administrator shall allow the Contractor to continue the expanded asphalt stabilization work based on an acceptable visual assessment of the trial section according to the requirements of the Grading and Compacting the Expanded Asphalt Mix subsection. When EAM is rejected by visual assessment, the Contractor shall repeat additional trial sections until the EAM meets the requirements of this specification.

The Contractor shall be responsible for the repair, removal, or replacement of an unacceptable trial section.

331.07.04 Expanded Asphalt Stabilization

The Contractor shall stabilize to the depth and limits detailed in the Contract Documents. The overlap between successive passes of the reclaimer-stabilizer shall be a minimum of 100 mm and a maximum of 150 mm.

If required, corrective aggregate or active filler or both shall be added to the roadway prior to stabilizing.

In areas that are inaccessible to the reclaimer-stabilizer equipment, existing asphalt pavement shall be removed and replaced with a minimum 100 mm of binder course hot mix placed flush with the adjacent EAM surface.

331.07.05 Grading and Compacting the Expanded Asphalt Mix

The material shall be compacted to a minimum 97% of the target density, as determined in OPSS 501 for granular materials.

The compacted surface of the EAM shall be according to the surface tolerances specified in OPSS 301. Regrading of the EAM to correct crossfall deficiencies shall be minimized.

The compacted surface of the EAM shall be uniform in texture and free of segregation, longitudinal streaks, flushing, fat spots, oil spills, roller marks, and other surface defects.

331.07.06 Sampling

The Contractor shall be responsible for all sampling.

331.07.06.01 Corrective Aggregate

The Contract Administrator may request samples of the corrective aggregate to demonstrate conformance to the requirements of this specification. When requested, two 25 kg samples shall be taken in the presence of the Contract Administrator.

QA samples shall be taken in accordance with procedures given in LS-625 and at the time and location determined by the Contract Administrator.

Samples of corrective aggregate shall be obtained, properly labelled and identified, and delivered within 48 hours of sampling to the designated QA testing laboratory as specified in the Contract Documents.

331.07.06.02 Active Filler

The Contract Administrator may request samples of active filler to demonstrate conformance to the requirements of this specification.

331.07.06.03 Expanded Asphalt Mix

Samples of unstabilized material and EAM shall be taken at a minimum frequency of one set of samples per 5,000 m². To obtain a set of samples, the Contractor shall take one 15 kg sample of unstabilized material immediately following in-place full depth reclamation and from the same approximate location a second 15 kg sample of EAM, immediately following stabilization. The maximum sampling depth shall be 100 mm. The second sample may be obtained after placement and prior to compaction.

The samples shall be packaged in a non-absorptive material to protect sample integrity, sealed in waterproof containers, appropriately labelled, and delivered by the Contractor in good condition within 48 hours of sampling to the designated QA testing laboratory specified in the Contract Documents.

331.07.07 Traffic Convoy

When specified in the Contract Documents, the Contractor shall convoy traffic according to the OTM, Book 7.

The pilot vehicle shall guide one-way traffic through or around construction. The maximum speed of the convoy shall be 30 km/h. Convoing shall be maintained until such time as the expanded asphalt stabilized mat is able to carry traffic without damage.

331.07.08 Management of Excess Material

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

331.08 QUALITY ASSURANCE

331.08.01 General

Acceptance shall be based on QA testing. QA testing shall be carried out by a laboratory currently certified by CCIL with Type A or Type B certification or AMRL accredited or equivalent laboratory.

Acceptance criteria shall be based on the QA test results for each 5,000 m² placed.

All unacceptable material and all unacceptable surface deficiencies, mix, or work shall be rejected. Defective material, mixture, and work shall not be incorporated into the finished work.

331.08.02 Acceptance of Corrective Aggregate

QA testing may be carried out to ensure that corrective aggregate to be used in the work is according to the physical property requirements of Granular A according to OPSS 1010.

331.08.03 Acceptance of the Expanded Asphalt Mix

331.08.03.01 Surface Appearance

Surface appearance shall be assessed by the Contract Administrator based on SP-027 manual after the EAM mat has been opened to traffic. The finished EAM surface shall have a uniformly smooth texture and be free from surface defects of ravelling, deformation, flushing, and rutting prior to placement of the HMA overlay.

331.08.03.02 Asphalt Cement Content

The sample of unstabilized material taken immediately following in-place full depth reclamation and the sample of EAM taken immediately after stabilization shall be tested for total asphalt cement content in accordance with LS-282 or LS-292. The total asphalt cement content of the EAM includes existing aged asphalt cement and new asphalt cement. The per cent by mass of new asphalt cement added to the unstabilized material shall be determined from the two samples at each location by subtracting the total asphalt cement content of the unstabilized material from the total asphalt cement content of the EAM.

The average new asphalt cement content of each 5,000 m² placed shall not be less than 0.4% or more than 0.6% of the established mix design.

331.08.03.03 Tensile Strength

Samples of EAM shall also be tested for dry tensile strength, wet tensile strength, and tensile strength ratio according to LS-297.

Dry tensile strength requirements for the sample are met when the dry tensile strength of the sample is equal to or greater than the minimum requirement of 225 kPa.

Wet tensile strength requirements for the sample are met when wet tensile strength of the sample is equal to or greater than the minimum requirement of 100 kPa.

The tensile strength ratio for the sample shall not be less than 50%.

331.08.04 Acceptance of Thickness

Thickness of the EAM shall be measured by the Contract Administrator. Measurements shall be taken by excavating along the edge of the stabilized pass with a shovel and measuring the depth of stabilization from the bottom of the EAM to the surface of the adjacent unstabilized material. Thickness requirements for each 5,000 m² are met when the following are satisfied:

- a) At least 90% of all thickness measurements for each 5,000 m² are equal to or greater than the specified thickness minus 20 mm.
- b) No individual thickness measurement for each 5,000 m² is less than the specified thickness minus 30 mm.

331.08.05 Acceptance of Compaction

Compaction measurements shall be taken by the Contract Administrator according to OPSS 501 for granular materials. Compaction requirements of the EAM placed are met when the following are satisfied:

- a) The average of all compaction measurements for each 5,000 m² is greater than or equal to 97% of the target density.
- b) No individual compaction measurement for each 5,000 m² is less than 95% of the target density.

331.08.06 Repairing and Re-Decisioning

With the exception of repairs for surface tolerance, the minimum width of repair shall be the full width of the reclaimer-stabilizer equipment, the minimum length shall be sufficient for the repair to be carried out, and all repairs shall be made using the same equipment as was used during initial production and placement.

To meet the specified surface tolerance, all deficient areas shall be re-profiled by grading or padding or padded with the same HMA type to be used in the overlying HMA lift.

Unacceptable EAM, including any area damaged or contaminated by traffic or by natural or added water shall be reprocessed and, if required, additional expanded asphalt added. Alternatively, the Contractor shall remove and replace damaged or otherwise unacceptable EAM with the same hot mix type to be used in the overlying hot mix lift to a minimum depth of 50 mm according to OPSS 310.

Mixes that cannot be compacted to the specified density shall be removed to a minimum depth of 50 mm and replaced by an appropriate HMA approved by the Contract Administrator. When it is determined that the compaction cannot be achieved due to poor subgrade conditions, the Owner shall be responsible for the cost of repairs.

331.09 MEASUREMENT FOR PAYMENT

331.09.01 Actual Measurement

331.09.01.01 Full-Depth Reclamation with Expanded Asphalt Stabilization

Full-depth reclamation with expanded asphalt stabilization shall be measured for payment by horizontal area in square metres.

331.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

331.10 BASIS OF PAYMENT

331.10.01 Full-Depth Reclamation with Expanded Asphalt Stabilization - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

The addition of corrective aggregate or active filler to the mix shall be at no extra cost to the Owner.

PGAC shall be included in the Full-Depth Reclamation with Expanded Asphalt Stabilization item.

Repair of unacceptable EAM shall be carried out at no extra cost to the Owner.

Repair of areas of EAM damaged by traffic shall be completed at no extra cost to the Owner.

Repair, removal, or replacement of an unacceptable trial section shall be completed at no extra cost to the Owner.

Appendix 331-A, November 2016 FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

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

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- The depths and widths for reclaiming existing asphalt pavement and underlying granular base. (331.07.02)
- The depth and limits of expanded asphalt stabilization. (331.07.04)

The designer should determine if the following is required and, if so, specify it in the Contract Documents:

- Traffic convoy requirements. (331.07.07)

Expanded asphalt mix (EAM) is a reclaimed asphalt pavement and granular base stabilized in-place by the addition of expanded asphalt and, if required, corrective aggregate and active filler.

EAM is a bound material and does not exhibit the same drainage characteristics as granular base material.

Expanded or "foamed" asphalt is created by injecting a carefully metered amount of cold water into hot asphalt cement in the mixing chamber of a pulverizer-stabilizer. The asphalt expands, reducing the viscosity of the asphalt cement and allowing easier dispersion throughout the mix.

The expanded asphalt bonds most effectively with finer aggregate particles forming a mortar to bond the coarser aggregate particles together. The stabilization process requires fines in order to be effective.

It is recommended that adequate pre-engineering be carried out on the project and that existing pavement thicknesses and composition be established. Additional investigation should be carried out when pavement composition changes, such as patched areas. Pre-engineering data should be included in the contract documentation.

The selected performance graded asphalt cement (PGAC) must have suitable expansion characteristics. Polymer modified PGAC may adversely affect the foaming process. There is no requirement for a PGAC to be selected based on climatic zones, as the stabilized layer is expected to have good fatigue properties and should not be prone to low temperature cracking.

Since EAM has a higher structural equivalency than granular base material, it is suitable for pavement strengthening purposes where aggregate availability is low or where elevation restrictions exist.

This specification requires that the EAM be paver laid, i.e., be placed by a self-propelled mechanical paver. If an Owner would like the EAM to be grader laid, i.e., to allow the use of a grader to place the EAM, a special provision to allow that option should be included in the Contract Documents.

When additional full-depth reclamation is required beyond the limits of the expanded asphalt stabilization, the depth and limits of full-depth reclamation should be clearly indicated in the Contract Documents. (331.07.02)

Appendix 331-A

When compaction is to be determined according to OPSS 501 Method B, a minimum roller size should be specified.

A minimum 2-Day curing period is recommended prior to overlaying the EAM. The EAM should be surfaced as soon as possible after curing, as the mix is susceptible to damage by traffic and rain.

A tack coat is recommended on the EAM prior to hot mix overlay.

EAM is typically overlain with hot mix asphalt. A surface treatment or slurry surfacing may be considered; however, this specification may require modification.

Contract scheduling should allow for stabilization and overlay to be completed within the hot mix temperature operational constraints.

QC requirements have been removed from this specification, as acceptance is based on QA testing. If an Owner requires Contractor QC to confirm that the work meets the specification requirements, a special provision detailing the required Contractor QC should be included in the Contract Documents.

The payment clause for this specification is all inclusive. Should an Owner desire to pay for corrective aggregate, active filler, or asphalt cement separately, separate payment items are required.

In times of volatile asphalt cement prices, on multi-year contracts, and on Contracts with greater than 1,000 tonnes of paver laid EAM material, designers may consider using the MTO PGAC price index for payment adjustment. The MTO PGAC price index is available on the Ontario Ministry of Transportation website at www.raqs.mto.gov.on.ca, by clicking on Contractor, Contract Bulletin, Asphalt Price Index. The MTO PGAC price index is only a tool for qualifying PGAC prices and is not intended as a standard asphalt cement price to be incorporated into the contract bid. The MTO PGAC price index calculation for a given month takes in the average of the 4 weeks of the month and is published on the last day of the month.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR HOT IN-PLACE RECYCLING

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332-A Commentary

332.01 SCOPE

This specification covers the requirements for the preparation of the existing pavement surface; heating and hot milling the existing hot mix asphalt; adding and mixing in one or more of rejuvenating agent and beneficiating hot mix asphalt; and redistribution and compaction of the Hot In-Place Recycled mix in a single operation.

332.01.01 Specification Significance and Use

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

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

332.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

332.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 310 Hot Mix Asphalt

Ontario Provincial Standard Specifications, Material

OPSS 1101 Performance Graded Asphalt Cement
OPSS 1150 Hot Mix Asphalt
OPSS 1151 Superpave and Stone Mastic Asphalt Mixtures

Ontario Ministry of Transportation Publications

MTO Laboratory Testing Manual

LS-261 Preparation of Marshall Specimens
LS-262 Bulk Relative Density of Compacted Bituminous Mixes
LS-263 Resistance to Plastic Flow of Bituminous Mixtures using Marshall Apparatus
LS-264 Theoretical Maximum Relative Density of Bituminous Paving Mixtures
LS-265 Determination of Percent Air Voids in Compacted Dense Bituminous Pavement Mixtures
LS-282 Quantitative Extraction of Asphalt Cement and Analysis of Extracted Aggregate from Bituminous Paving Mixtures
LS-284 Recovery of Asphalt from Solution by Abson Method or Rotavapor
LS-287 Determination of Percent Compaction of Compacted Bituminous Paving Mixture (MRD Method)

- LS-292 Quantitative Determination of Asphalt Cement Content by Ignition and Analysis of Remaining Aggregate from Bituminous Paving Mixtures
LS-306 Bulk Relative Density of Compacted Bituminous Mixtures Using Paraffin Coated Specimens

ASTM International

- D 6752-11 Standard Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Automatic Vacuum Sealing Method

American Association of State Highway and Transportation Officials (AASHTO)

- M 323-13 Superpave Volumetric Mix Design
T 166-13 Bulk Specific Gravity of Compacted Bituminous Mixtures Using Saturated Surface-Dry Specimens
T 209-09 Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures
T 275-07 Bulk Specific Gravity of Compacted Bituminous Mixtures Using Paraffin-Coated Specimens

332.03 DEFINITIONS

For the purpose of this specification, the definitions in OPSS 310, OPSS 1150, OPSS 1151, and the following definitions apply:

Asphalt Cement (AC) means asphalt binder as defined in OPSS 1101.

Attribute means one of the following properties: designated large sieve (DLS), 4.75 mm sieve, 75 µm sieve, AC content, air voids, lift thickness, compaction, or recovered asphalt cement (RAC) performance grade.

Beneficiating HMA means a HMA designed so that the final HIR mix shall be as specified in the Contract Documents.

Design Lift Thickness (T_D) means the thickness in millimetres of the HIR mix as specified in the Contract Documents.

High Temperature Performance Grade (XX) means the high temperature performance grade specified in the Contract Documents and also referred to as the XX specified for the RAC where the RAC grade specified is PG XX-YY, and the maximum design pavement temperature.

Hot In-Place Recycled (HIR) Mix means the mixture of hot milled material containing one or more of the following components: rejuvenating agent and beneficiating HMA.

Hot Milled Material means the material produced during the heating and hot milling of the existing HMA.

Hot Milling means the process of applying adequate heat to the pavement to sufficiently soften the pavement, followed by the use of milling heads to uniformly remove the heated material to the depth specified in the mix design submission with minimal fracturing of the existing aggregates.

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

Lift Thickness means the thickness in millimetres of the placed and compacted HIR mix.

Loose Mix means a representative sample of uncompacted HIR mix for testing mix properties or the RAC performance grade.

Low Temperature Performance Grade (-YY) means the low temperature performance grade specified in the Contract Documents and also referred to as the -YY specified for the RAC where the RAC grade specified is PG XX-YY, and the minimum design pavement temperature.

Mix Design means the design of the proportions of new and existing aggregates; new and existing AC; rejuvenating agent; and additives; when uniformly mixed, that results in an acceptable HIR mix.

Mix Properties means the AC content, gradation, and air voids.

Recovered Asphalt Cement (RAC) means the AC recovered from the HIR mix according to the Rotavapor Method in LS-284, using re-agent grade trichlorethylene, or other solvent acceptable to the Owner.

Rejuvenating Agent means a product that when added to the hot milled material; the RAC from the HIR mix meets the requirements of the Contract Documents.

Screed means the unit of the placement unit of the recycling train that strikes off and imparts initial compaction to the HIR mix.

332.04 DESIGN AND SUBMISSION REQUIREMENTS

The HIR mix design shall be as specified in the Contract Documents and according to the Design and Submission Requirements section of OPSS 1150 for HIR mixes required to meet a Marshall mix type and OPSS 1151 for HIR mixes required to meet a Superpave mix type.

HIR mix designs shall not incorporate RAP from other sources or RST into the HIR mix.

The following additional information shall be submitted to the Contract Administrator in writing with the mix design:

- a) The amount, name, manufacturer, and supplier of the rejuvenating agent or beneficiating HMA or both, if to be used;
- b) The hot milling depth to meet the required mix properties and the design lift thickness, as specified in the Contract Documents, with a maximum increase in pavement elevation of 15.0 mm;
- c) The mix proportions, gradation, and source of the materials in the beneficiating HMA, if to be used;
- d) A copy of all calculations that were completed to determine the amount of rejuvenating agent or beneficiating HMA or both, if to be used;
- e) Air void laboratory test results and calculations for the HIR mix; and
- f) A graph of temperature-kinematic viscosity relationship for the combined rejuvenating agent, the recovered AC present in the existing pavement, and the new AC in the beneficiating HMA.
- g) When applicable, a declaration that the percentage of the beneficiating HMA comprising quartzite and dolomitic sandstone aggregates, or combinations thereof, is more than 75%.

Each mix design shall be valid for the section of roadway it was designed for.

332.05 MATERIALS

332.05.01 Hot In-Place Recycled Mix

The HIR mix produced shall be according to the mix design and meet the requirements of Tables 1, 2, and 3. For HIR mix required to meet a Marshall mix type, the HIR mix produced shall also meet the requirements of Table 4.

332.05.01.01 Recovered Asphalt Cement

The RAC recovered from the HIR mix produced shall be according to the Materials section of OPSS 1101 for PGAC and as specified in the Contract Documents.

332.05.01.02 Beneficiating Hot Mix Asphalt

The materials used in the production of the beneficiating HMA shall be according to OPSS 1150 for HIR mixes required to meet a Marshall type and OPSS 1151 for HIR mixes required to meet a Superpave mix type.

The composition of the beneficiating HMA shall not contain RAP or RST.

332.05.02 Release Agents

No release agents shall be used that may adversely affect the quality or performance of the HIR mix. Release agents shall be used according to the proprietary requirements.

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

332.06 EQUIPMENT

332.06.01 Paving Equipment

Paving equipment shall be according to OPSS 310.

332.06.02 Rollers

Rollers shall be according to OPSS 310.

332.06.03 Heating Unit

Heating units shall apply heat in a uniform manner to the surface of the existing pavement to be hot milled. Open flame heating of the existing HMA pavement shall not be permitted.

Heaters shall be spaced and operated so that:

- a) Sufficient heat penetration of the pavement shall be achieved, with heat penetration into the underlying pavement beneath the hot milling depth specified in the mix design submission;
- b) The desired HIR mix temperatures are achieved; and
- c) The existing HMA surface is not burnt or scorched.

332.06.04 Recycling Train

The recycling train shall be self-contained mechanical units specifically designed for HIR of HMA pavements. The recycling train shall have the capability to process the existing pavement to a depth of at least 50 mm.

Heaters used as part of the recycling train shall be according to the Heating Unit subsection.

The recycling train shall include hot milling, blending, and placement units.

332.06.04.01 Hot Milling Unit

The hot milling unit shall be capable of uniformly milling the preheated HMA to the hot milling depth specified in the mix design submission.

332.06.04.02 Blending Unit

The blending unit shall be capable of thoroughly mixing the hot milled material, rejuvenating agent, and beneficiating HMA.

332.06.05 Diamond Grinding

A diamond grinder shall be power-driven, self-propelled, and designed for grinding HIR mix or HMA. It shall be equipped with a grinding head with at least 50 diamond blades per 300 mm of shaft. The grinding head shall be at least 0.9 m wide. The grinder shall be equipped with the capability to adjust the depth, slope, and crossfall to remove HIR mix or HMA to the required profile and shall also include a slurry pick-up system.

332.07 CONSTRUCTION

332.07.01 Quality Control

QC procedures shall be conducted to ensure the HIR mix meets the requirements of the Contract Documents. The Contractor shall be responsible for interpretation of the QC test results and the determination of any action to be taken to ensure that all materials and work are as specified in the Contract Documents. QC documentation shall be made available to the Contract Administrator upon request. Sampling and testing methods shall be included in the QC documentation.

A laboratory that has current CCIL Type B Certification or AMRL equivalent certification or other equivalent certified laboratory acceptable to the Contract Administrator shall be used. Testing of the samples shall be conducted under the direct and constant supervision of technicians certified to perform the QC tests according to CCIL or equivalent certification.

A single sample for QC purposes may be obtained at the same time and location as QA acceptance samples. No additional loose mix samples shall be taken from the placed HIR mix. If further additional samples are required, a written request shall be made to the Contract Administrator, and samples shall only be taken upon written approval of the Contract Administrator. All sample locations shall be restored as specified in the Contract Documents.

332.07.02 Preparation of Existing Pavement

Prior to the HIR operation:

- a) Existing HMA surfaces shall be clean and free of all loose, broken, and foreign materials.
- b) Milled existing HMA surfaces shall be clean and free of all loose, broken, and foreign materials and shall be swept with a power broom.

c) Removal of cold mix patching material, crack sealant, and spray patch material shall be as specified in the Contract Documents (FS: pp 44)
Existing surfaces to be HIR may be corrected by additional cold milling, hot milling, addition of beneficiating HMA or a combination, in order to place and compact the HIR mix to the design thickness specified in the Contract Documents.

Removal of the existing pavement by the hot milling unit shall be performed in such a manner as to leave adjacent pavement and structures remaining in place undisturbed and undamaged. All damaged or disturbed portions shall be corrected expeditiously and repaired to the satisfaction of the Contract Administrator. Broken edges of portions to be left in place that are visible after construction shall be squared and neatly trimmed.

332.07.03 Transportation of Beneficiating Hot Mix Asphalt

The beneficiating HMA shall be transported from the asphalt plant to the work in leak proof truck boxes that have been previously cleaned of all foreign materials. If required, truck boxes shall be lightly coated with a uniform application of a release agent. Truck boxes shall be drained after each application and before loading.

Each truck shall use a tarpaulin of sufficient size to completely cover the load at all times.

332.07.04 Placing Hot In-Place Recycled Mix

332.07.04.01 Operational Constraints

The HIR process shall not be carried out if the roadbed is frozen.

The surface of a pavement which is to be HIR shall be dry at the time of the HIR processing. The HIR process shall be carried out when the roadway is clean and free of standing water. The HIR process shall not proceed in the rain.

The supply of any materials to the recycling train shall be accomplished with no traffic on the uncompacted mat. Public traffic shall not be permitted on freshly laid HIR mix until the temperature of the mat is 50 °C or less.

332.07.04.02 Paving

The heating units and recycling train shall heat and hot mill the HMA pavement across the complete lane width, and partial width shoulder if applicable, to the hot milling depth specified in the mix design submission.

The underlying pavement shall be heated to a minimum temperature of 50 °C.

When inspection and testing indicates that the required average depth of heating and hot milling is not being met, the process shall be immediately corrected.

Rejuvenating agent and/or beneficiating HMA shall be added to and mixed with the hot milled material in the amount specified in the mix design. The HIR mix shall be homogeneous after mixing.

The final placement of the HIR mix by the recycling train shall be uniformly distributed to the specified profile and crossfall. The HIR mix shall be compacted to the design lift thickness specified in the Contract Documents and meet all acceptance criteria specified in the Contract Documents.

Each successive pass of the recycling train shall overlap the previously HIR adjacent surface by a minimum of 100 mm.

The temperature of the HIR mix immediately behind the screed and prior to rolling shall not be less than 120 °C.

Prior to roller compaction, obvious defects in the HIR mix placed shall be corrected. Irregularities in the alignment and grade along the outside edges shall be corrected. Excess HIR mix shall not be cast onto the surface of the freshly laid mat. After final compaction the surface shall be smooth and true to the established crown and grade, uniform in texture and shall be free of any defects.

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

Areas that are not accessible to the heating and hot milling equipment shall have the HMA removed to the depth required to meet the design lift thickness requirements specified in the Contract Documents. These areas shall be tacked coated and paved with the HMA mix type the HIR is required to meet according to OPSS 310. The surface of each layer placed and compacted shall be level with the adjacent pavement. The paving of such areas shall be completed prior to the placing of any subsequent course on the HIR mix, if applicable, and as a separate operation from any other paving.

If the Contractor's actions fail to prevent continued medium or severe segregation regardless of cause, the Contract Administrator may instruct the Contractor to cease HIR operations until the problem has been corrected.

332.07.05 Longitudinal and Transverse Joints

All joints shall be made to obtain a complete bond between the two pavement edges and a smooth riding surface. The existing or previously placed pavement edge shall be a straight clean vertical surface for the full depth of the course. Where ramping or damage has occurred, trimming shall be required. All dirt or other foreign material and all loose material shall be removed from all vertical surfaces.

Longitudinal and transverse joints between the new HIR pavement and the existing pavement shall be butt joints as specified in the Contract Documents. All longitudinal joints at intersecting roads shall be butt joints. Heating beds on the heating units shall heat and soften material beyond the hot milling width by a minimum of 100 mm to achieve proper thermal bonding between the existing asphalt pavement and the HIR mix along the longitudinal joints. The longitudinal joints shall be parallel to the lane and visually uniform longitudinally, and within 50 mm of the demarcation between the lanes specified in the Contract Documents.

When matching a compacted joint, the depth of the uncompacted mat shall be set to allow for compaction. The paver screed shall overlap the adjoining mat by at least 50 mm.

332.07.06 Compaction

Compaction of the HIR mix shall be conducted using appropriate methods and equipment to provide a uniformly compacted mat according to the compaction requirements as per OPSS 310.

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

332.07.07 Sampling

332.07.07.01 General

Samples shall be taken in accordance with the Contract Documents under the direction and in the presence of the Contract Administrator. Samples shall be placed in an appropriate container supplied by the Owner.

HIR mix and compaction requirements for filling all sample holes shall be the same as the adjacent undisturbed pavement. Sample holes shall be cleaned, dried, and filled and then compacted using a mechanical self-powered gas-, electric-, or air-powered compactor immediately after sampling.

332.07.07.01.01 Labelling

All samples shall be labelled with the following:

- a) Contract number.
- b) Location of sampling.
- c) Date (i.e., yyyy-mm-dd) and time of sampling.
- d) Asphalt type.

332.07.07.02 Hot In-Place Recycled Mix

The Contractor is responsible for obtaining QA and referee HIR mix samples using sample plates for Marshall mixes and other methods approved by the Contract Administrator for Superpave mixes.

When the mass of the sample does not meet the requirements of Table 5, the sample shall be discarded and a new one taken immediately.

332.07.07.02.01 Frequency and Location

The minimum frequency for sampling and testing shall be as specified in Table 5.

332.07.07.03 Lift Thickness Cores

The Contractor is responsible for obtaining QA and referee lift thickness core samples.

Each core shall be 100 mm in diameter, and shall consist of the full layer being sampled and at least one underlying layer, if one is present. Cores shall not be taken within 250 mm of a longitudinal or transverse joint or the edge of pavement.

332.07.07.03.01 Frequency and Location

The minimum frequency for sampling and testing shall be approximately once every 100 m along the length of the roadway or 300 m² of pavement surface.

332.07.07.04 Compaction Cores

When a coring and testing program is undertaken to resolve a dispute related to HIR compaction, the Contractor shall be responsible for all traffic control required to carry out the coring, obtaining, and labelling the core samples, delivery of the samples to a mutually agreed upon third party referee laboratory, and repairing core sample holes.

Each core shall be 150 mm in diameter, and shall consist of the full layer being sampled and at least one underlying layer, if one is present. Cores shall not be taken within 250 mm of a longitudinal or transverse joint or the edge of pavement.

Each set of samples shall be taken from the same lane, same transverse offset, and at a spacing of 1.0 m ± 0.1 m between each individual core edge.

Care shall be taken to ensure that cores are not damaged during coring operations or in transit. If a core is damaged, a replacement core shall be extracted at a location adjacent to the original core.

332.07.07.04.01 Frequency and Location

The minimum frequency of sampling and testing shall be as determined by the Contract Administrator.

332.07.08 Management of Excess Material

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

332.08 QUALITY ASSURANCE

332.08.01 General

The Contract Administrator is responsible for conducting QA procedures for all HIR attributes to meet the requirements of the Contract Documents. QA HIR testing shall be conducted at a frequency specified in Table 5 or as specified in the Contract Documents.

All QA testing shall be completed in a certified laboratory that is CCIL Type B or C, or AMRL accredited, or equivalent.

When the HIR fails to meet the requirements of the Contract Documents, the Contract Administrator may refuse further material until the mix properties are verified for compliance by one of the following methods:

- a) For Marshall mixes, samples shall be used to determine compliance to asphalt cement content, aggregate gradation, air voids, flow, voids in mineral aggregate, and stability requirements.
- b) For Superpave mixes, samples shall be used to determine compliance to asphalt cement content, aggregate gradation, and Superpave mix properties in accordance to AASHTO M 323.

332.08.02 Surface Tolerance

After final compaction, HIR mix shall be smooth and true to the established crown and grade. HIR mix shall be free from deviations exceeding 3 mm as measured in any direction with a 3 m straight edge. Defective areas shall be removed and replaced with acceptable HIR or HMA pavement and compacted to the satisfaction of the Contract Administrator.

332.08.03 Surface Appearance

The Contract Administrator may reject visually defective HIR areas based on, but not limited to the following defects: flushing, segregation, fat spot, surface damage, roller marks, or surface contamination. Defective areas shall be removed from the work and replaced with acceptable HIR or HMA pavement and compacted to the satisfaction of the Contract Administrator.

332.08.04 Asphalt Cement Content and Aggregate Gradation Acceptance

Aggregate gradation and asphalt cement content test results for HIR mix samples based on LS-282 and LS-292 shall meet the requirements specified in Table 1.

If the HIR mix is deemed borderline for aggregate gradation or asphalt cement content according to Table 1, the Contractor shall be notified in writing by the Contract Administrator and shall take immediate corrective action through process control. A total of three borderline test results for the same attributes representing up to 40,000 m² of HIR production shall result in the work being deemed rejectable.

Test results shall be acceptable if they meet the requirements specified in Table 1. If the HIR mix is deemed rejectable according to Table 1, both the Contract Administrator and the Contractor shall review, agree, and

identify the limits of rejected HIR mix that has been placed. Referee samples within the limits of the affected area shall be delivered by the Contractor to a mutually agreed upon third party referee laboratory to verify aggregate gradation or asphalt cement content or both. When the results from the referee samples are deemed rejectable according to Table 1, the HIR mix shall be removed and replaced with acceptable HIR or HMA pavement. Alternatively, the Contract Administrator may accept a guaranteed maintenance bond, an increased maintenance period, or a negotiated price adjustment.

332.08.05 Mix Properties Acceptance

The production air voids for all HIR mixes shall be evaluated according to Table 2. Marshall test results for HIR mix samples based on LS test procedures shall also meet the requirements specified in Table 4.

If the HIR mix is borderline for air voids as specified in Table 2, the Contractor shall be notified in writing by the Contract Administrator and shall take immediate corrective action through process control.

If the HIR mix does not meet Table 4 minimum requirements for Marshall stability or Marshall flow or is deemed rejectable for air voids according to Table 2, both the Contractor Administrator and the Contractor shall review, agree, and identify the limits of the rejected HIR mix that has been placed. Referee samples within the limits of the affected area shall be delivered by the Contractor to a mutually agreed upon third party referee laboratory to verify Marshall test or air voids results or both. When the results from the referee samples do not meet Table 4 minimum requirements or are deemed rejectable according to Table 2, the HIR mix shall be removed and replaced with acceptable HIR or HMA pavement. Alternatively, the Contract Administrator may accept a guaranteed maintenance bond, an increased maintenance period, or a negotiated price adjustment.

332.08.06 Lift Thickness Acceptance

The average thickness for a lift thickness core shall be based on the measurement from each quadrant of the core. The average thickness for the area shall be determined by averaging the core thicknesses.

When the average thickness is more than or equal to 95% of the specified thickness, the total surface area of the HIR mix is acceptable.

When the average thickness is less than 95% of the specified thickness, the area represented by the lift thickness core shall be subject to a payment adjustment as specified in the Payment Adjustment for Lift Thickness subsection.

332.08.07 Recovered Asphalt Cement Performance Grade Acceptance

All RAC test samples shall be obtained by recovery according to the Rotavapor Method in LS-284 using re-agent grade trichloroethylene, or other solvent acceptable to the Owner, from the loose mix HIR mix samples taken as specified in Table 5.

Test results that do not comply with the performance grading requirements shall be categorized as borderline or rejectable. RAC test results shall be categorized based on each test result's deviation from the individual design maximum or minimum pavement temperature and the sum of the deviations from the design maximum or minimum pavement temperatures defined as specified in Table 6. The actual performance grading that is either higher than the maximum design pavement temperature or lower than the minimum design pavement temperature is not considered a deviation.

If the HIR mix is deemed borderline for RAC performance grade according to Table 6, the Contractor shall be notified in writing by the Contract Administrator and shall take immediate corrective action through process control. A total of three borderline test results for the same attributes representing up to 40,000 m² of HIR production shall result in the work being deemed rejectable.

Test results shall be acceptable if they meet the requirements specified in Table 6. If the HIR mix is deemed rejectable according to Table 6, both the Contract Administrator and the Contractor shall review, agree, and identify the limits of rejected HIR mix that has been placed. Referee samples within the limits of the affected area shall be delivered by the Contractor to a mutually agreed upon third party referee laboratory to verify the RAC performance grading. When the results from the referee samples are deemed rejectable according to Table 6, the HIR mix shall be removed and replaced with acceptable HIR or HMA pavement. Alternatively, the Contract Administrator may accept a guaranteed maintenance bond, an increased maintenance period, or a negotiated price adjustment.

332.08.08 Compaction Requirements

332.08.08.01 General

Compaction testing of the placed HIR mix shall meet the requirements specified in Table 3.

Nuclear density test gauge results shall be used to assess in-place compaction. When compaction test results do not meet the minimum percent compaction specified in Table 3, the Contractor shall be notified in writing and either the affected area of HIR shall be removed and replaced with acceptable HIR or HMA, or in the case of a dispute, the Contractor or the Owner may request that a coring and testing program be undertaken to verify compaction percentage of the mix. The cores shall be provided to the Owner and compaction shall be determined according to the Compaction Determined by Core Density Testing clause using a mutually agreed upon third party referee laboratory. When compaction results from core densities do not meet the minimum percent compaction specified in Table 3, the HIR shall be removed and replaced with acceptable HIR or HMA.

332.08.08.02 Compaction Determined by Nuclear Density Gauge

Compaction testing shall be conducted randomly at a minimum frequency of every 100 m per lane or 150 m² area.

332.08.08.02.01 Marshal Hot In-Place Recycled Mix

Percent compaction shall be determined by comparing the nuclear density in situ Bulk Relative Density (BRD) according to LS-262 to the average plant produced Maximum Relative Density (MRD) according to LS-264.

332.08.08.02.02 Superpave Hot In-Place Recycled Mix

Percent compaction shall be determined by comparing the nuclear density in situ BRD to the average plant produced MRD both according to AASHTO T 209.

332.08.08.03 Compaction Determined by Core Density Testing

332.08.08.03.01 Marshall Hot In-Place Recycled Mix

Density testing of the cores shall be according to LS-287. Percent compaction shall be determined by comparing the core BRD according to LS-262 to the average MRD according to LS-264 of the plant produced HIR.

332.08.08.03.02 Superpave Hot In-Place Recycled Mix

Density testing of the cores shall be according to AASHTO T 166. If the percent water absorbed by the specimen is found to exceed 2% by volume as described in AASHTO T 166, then the bulk specific gravity shall be according to AASHTO T 275, LS-306, or ASTM D 6752. Percent compaction shall be determined by comparing the core BRD to the average MRD both according to AASHTO T 209 of the plant produced HIR.

332.09 MEASUREMENT FOR PAYMENT

332.09.01 Actual Measurement

332.09.01.01 Hot In-Place Recycled Mix

Measurement of HIR mix shall be by the horizontal area in square metres in place.

332.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement is based on the units shown in the clauses under Actual Measurement.

332.10 BASIS OF PAYMENT

332.10.01 Hot In-Place Recycled Mix– Item

Payment at the Contract price for the above tender item shall include full compensation for all labour, Equipment, and Materials required to do the work, including rejuvenating agent and beneficiating HMA quantities if used, and the applicable payment adjustments.

No additional payment shall be made for the work, labour, Equipment, and Materials required to remove the existing pavement, and place HMA in areas not accessible to the heating and hot milling equipment.

The preparation and correction of existing HMA surfaces carried out in order to meet the requirements of the Contract Documents, including removal of materials such as cold mix patching material, crack sealant, and spray patch material; cold milling, hot milling, and the addition of beneficiating HMA; shall be at no cost to the Owner.

HMA required to retrofit partially paved shoulders or for pavement widening shall be paid for at the Contract price for the appropriate HMA tender item. No additional payment shall be made under this item for HMA required to retrofit partially paved shoulders or for pavement widening.

When removing and replacing HIR mix, the Contractor shall be responsible for and shall carry out all associated work and replace or restore all associated damage and removals at no cost to the Owner.

Referee testing undertaken to resolve a dispute shall be at no extra cost to the Owner if the referee test results confirm that the HIR mix does not meet the requirements or is deemed borderline or rejectable according to the Quality Assurance section.

A coring, testing, and traffic control program undertaken to resolve a dispute shall be at no extra cost to the Owner if the HIR mix compaction is confirmed to not meet the requirements of the Compaction Requirements subsection.

When the Contract Administrator instructs the Contractor to cease HIR operations due to continued medium or severe segregation regardless of cause, the Owner shall not be held responsible for any additional costs that the Contractor may incur.

332.10.02 Payment Adjustment for Lift Thickness

When the average thickness is less than 95% of the specified thickness, the area represented by the lift thickness core shall be subject to a payment adjustment calculated as follows:

Payment for the area = $\frac{\text{area} \times \text{average thickness}}{\text{specified thickness}}$

TABLE 1
Asphalt Cement Content and Aggregate Gradation Tolerance Requirements

Properties and Attributes	Tolerance on	Tolerances %		
		Acceptable	Borderline	Rejectable
Asphalt Cement Content	Asphalt Cement Content specified (Note 1)	< 0.30	0.30 to 0.50	> 0.50
Designated Large Sieve (DLS)	Maximum and Minimum Percent Passing (Note 2 & 3)	< 1.0	1.0 to 5.0	> 5.0
4.75 mm Sieve	Maximum and Minimum Percent Passing (Note 2 & 3)	< 1.0	1.0 to 5.0	> 5.0
75 µm Sieve	Maximum Percent Passing (Note 2)	< 1.0	1.0 to 3.0	> 3.0
	Minimum Percent Passing (Note 3)	< 1.0		> 1.0
Notes: 1. Tolerances on the asphalt cement content specified in the Contract Documents apply as both plus and minus from the asphalt cement content specified in percent. 2. Tolerances on the maximum percent passing apply as plus from the maximum percent passing by dry mass of aggregate for the mix type the HIR mix shall be according to OPSS 1150 for Marshall mixes and OPSS 1151 for Superpave mixes. 3. Tolerances on the minimum percent passing apply as minus from the minimum percent passing by dry mass of aggregate for the mix type the HIR mix shall be according to OPSS 1150 for Marshall mixes and OPSS 1151 for Superpave mixes.				

TABLE 2
Air Voids Requirements (LS-265)

Properties and Attributes	Mix Type HIR Mix is Required to Meet	Acceptable %	Borderline %	Rejectable %
Air Voids	DFC	2.0 to 4.5	1.5 to 1.9 and 4.6 to 5.0	< 1.5 and > 5.0
	All Other Mixes	2.5 to 5.0	1.5 to 2.4 and 5.1 to 6.0	< 1.5 and > 6.0

TABLE 3
Minimum Pavement Compaction Based on Maximum Relative Density

Properties and Attributes	Minimum Compaction %
Pavement Compaction	92.0

TABLE 4
Marshall Stability and Flow Properties

Mix Type HIR Mix is Required to Meet	Marshall Flow at 3.5% Air Voids: LS-261 and LS-263	Minimum Marshall Stability: Newtons (N) at 60 °C, LS-261 and LS-263
DFC	8.0 minimum	(Note 1)
HL 1, HL 3, and HL 4,	8.0 to 14.0	
HL 3F	9.0 to 18.0	
Notes: 1. Stability requirements shall be according to OPSS 1150.		

TABLE 5
Sampling and Testing of Hot In-Place Recycled Mix

Material Sample	Properties and Attributes	Quantity Per Day Per HIR Mix Type	Minimum Frequency of Sampling and Testing (Note 1)	Minimum Sampling Size
HIR Loose Mix	Asphalt Cement Content, Aggregate Gradation, and Mix Properties	$\leq 4,000 \text{ m}^2$	One sample	20 kg (Note 2)
		$> 4,000 \text{ and } \leq 12,000 \text{ m}^2$	One sample per $4,000 \text{ m}^2$ or part thereof	
		$> 12,000 \text{ m}^2$	One sample per $4,000 \text{ m}^2$ (Note 2), minimum of 3	
HIR Loose Mix	RAC Performance Grade	Any	One sample per $40,000 \text{ m}^2$	10 kg
HIR Lift Thickness Core	Lift Thickness	Any	every 100 m along the length of the roadway or 300 m^2 of pavement surface	100 mm in diameter
HIR Compaction Core	Pavement Compaction	Any	every 100 m per lane or 150 m^2 of pavement surface	150 mm in diameter (Note 3)
Notes:				
1. The Contract Administrator may reduce the testing frequency for HIR mix that is consistently being produced to meet the specification requirements.				
2. For HIR mixes required to meet Marshall mix requirements the minimum sampling size shall be 10 kg.				
3. HIR compaction core only required when compaction shall be determined by core density testing as specified in the Contract Documents.				

TABLE 6
Performance Grading Requirements and Categories for RAC

Category	Deviation (Note 3)	RAC Requirements
Borderline (Note 1)	below XX and	$\leq 6^{\circ}\text{C}$
	above -YY and	$\leq 8^{\circ}\text{C}$
	Sum	$> 8^{\circ}\text{C}$ and $\leq 12^{\circ}\text{C}$
Rejectable (Note 2)	below XX or	$> 6^{\circ}\text{C}$
	above -YY or	$> 8^{\circ}\text{C}$
	Sum	$> 12^{\circ}\text{C}$
Notes: 1. Performance grading shall be deemed borderline when both the individual deviations and the sum of deviations specified for the category are met. 2. Performance grading shall be deemed rejectable when any individual deviation or the sum of deviations specified for the rejectable category is met. 3. XX is the specified high temperature performance grade and design maximum pavement temperature. -YY is the specified low temperature performance grade and design minimum pavement temperature.		

Appendix 332-A, November 2016
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

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

Designer Action/Considerations

The designer should be aware of the following when selecting HIR:

HIR is limited to resurface pavements exhibiting only surficial distresses. HIR should be considered for roads with the following distress manifestations:

- Very slight to moderate ravelling / coarse aggregate loss, segregation, very slight to moderate flushing, and/or distortions
- Few to frequent very slight to moderate non-working cracks
- For 2 lane highways up to 1.0% correction in crossfall can be achieved across a single lane width using HIR, provided there are no bridge clearance or grade raise restrictions
- For multi-lane highways correction of crossfall with HIR is not recommended

HIR is not suitable for pavements exhibiting structural distresses, i.e. alligator cracking, lack of structural capacity, working cracks, severe distortions, and/or instability rutting. HIR is not suitable for pavements exhibiting severe or very severe ravelling / coarse aggregate loss due to stripping.

HIR is not permitted for use on bridge decks; therefore, if the contract contains multiple bridges that require paving, the designer should consider whether stopping and starting the HIR process at each bridge is acceptable for the contract.

HIR is recommended only for existing flexible pavements, excluding SMA, with a minimum asphalt pavement thickness of 70 mm. The specified HIR lift thickness is 40 mm to a maximum of 50 mm (including any beneficiating HMA). The measured lift thickness is the actual lift thickness of the HIR placed and may or may not be equal to the hot milling depth. A minimum of 25 mm of existing asphalt pavement should be maintained below the HIR.

The HIR process should not be used to recycle SMA or composite pavements.

HIR must be placed in warm, dry weather; and therefore, HIR contracts should be tendered so that the HIR work can be carried out between May 15th and October 15th, inclusive.

The designer should note that HIR equipment may be restricted to a specific processing width. The equipment is usually able to process a width of up to 4.0 m. This could restrict the use of HIR with partially paved shoulders. However, the placement width is similar to that of a conventional paver, and partially paved shoulders that cannot be removed along with the lane, due to the restricted processing width, could be removed conventionally ahead of the HIR operation to allow the new partially paved shoulder to be placed in conjunction with the lane. Partially paved shoulders that cannot be accommodated as part of the lane placement width and fully paved shoulders, if these are to be HIR, require a separate pass of the HIR equipment.

HIR is usually considered for projects at least 20 lane-kilometres, including fully paved shoulders. Partially paved shoulders and pavement widening can be retrofitted using this process. Advance grading and

compaction of the shoulders is required as well as beneficiating HMA to make up the extra being placed on the shoulders or in pavement widening.

The following information is given for estimating purposes only.

HIR can be considered a suitable resurfacing treatment for a project where the pre-engineering cores meet the following guidelines:

1. The existing aggregate gradation should meet the gradation requirements of mix type the HIR is required to meet, or be close enough that a reasonable amount of beneficiating HMA could be added to meet these requirements.
2. The RAC performance grade from the extracted AC of the existing asphalt pavement can achieve the target performance grade using the blending calculations in AASHTO M 323 for rejuvenator products and new PGAC added to a beneficiating HMA.
3. Average in-situ air voids of:
 - > 4.5% a beneficiating HMA is normally not required,
 - ≤ 4.5% and > 2.0% beneficiating HMA may be required, and
 - ≤ 2.0% the designer should expect beneficiating HMA to be required.

Generally in-situ air voids are between 2.0 and 2.5% for asphalt pavements 10 to 15 years old.

4. The existing pavement conditions should not vary greatly from one core to the next.

The designer should specify the following in the Contract Documents:

- HIR crossfall, profile, cross-section, and alignment. (323.03)
- HMA mix type the HIR mix is required to meet. A Marshall mix type or Superpave 12.5 mix type should be selected based on existing materials from the following list: (332.04)
 - A. Superpave 12.5
 - B. Superpave 12.5FC 1
 - C. Superpave 12.5FC 2
 - D. DFC
 - E. HL 1
 - F. HL 3
 - G. HL 3F
 - H. HL 4
- Design thickness. (323.04)
- The RAC recovered from the HIR mix produced. (332.05.01.01)
- Quality assurance sample requirements. (332.07.01)
- HIR sample delivery location. (332.07.01)
- Removal of cold mix patching material, crack sealant, and spray patch material. (332.07.02)
- Lane demarcation. (332.07.05)
- Longitudinal and transverse joints. (332.07.05)

- Management of excess material. (332.07.08)
- QA HIR testing frequency if different than OPSS 332, Table 5. (332.08.01)
- Performance grade requirement for RAC. (332.08.07)
- Asphalt cement content specified. (Table 1)
- HIR compaction core. (Table 5)

Any available core data on existing pavement conditions should be included in the bidding documents for information only.

The designer should determine if the following is required and, if so, specify in the Contract Documents:

The designer may specify in a special provision when quality control (QC) test results are to be used for acceptance in place of QA test results.

The designer may consider extending delivery times for samples required on Contracts in remote areas. The designer should be aware that there is a 4 hour delivery requirement for samples and the laboratory should be open to receive them.

For smaller projects, the borderline category for tolerances in Table 1 may not be appropriate. The designer may consider specifying that all work represented by borderline test results shall be deemed rejectable.

The complete tender item description for HIR should include a “type” of HMA according to Table 1 of OPSS 1150 for HIR mixes required to meet Marshall mixes and according to Tables 1 and 2 of OPSS 1151 for HIR mixes required to meet Superpave mixes.

The designer should consider specifying that prior to HIR all materials such as cold mix patching material, crack sealant, and spray patch material shall be removed or that the Contractor shall be responsible for preparing the existing HMA surface by removing all materials such as cold mix patching material, crack sealant, and spray patch material, as the Contractor deems necessary, to heat, hot mill, blend, and place the HIR mix to meet the surface tolerance and surface appearance requirements as specified in the Contract Documents.

For premium mixes, the designer should consider specifying that correcting the existing pavement by cold milling prior to HIR should not result in the existing binder course pavement materials being hot milled and added to the HIR mix.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR COLD IN-PLACE RECYCLED MIX

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333-A	Commentary

333.01 SCOPE

This specification covers the requirements for cold in-place recycling of existing hot mix asphalt (HMA) pavement; sizing; adding corrective aggregate or active filler or both, if required; adding and mixing of emulsified asphalt; and spreading and compacting the cold in-place recycled (CIR) mix.

333.01.01 Specification Significance and Use

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

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

333.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

333.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 310 Hot Mix Asphalt

Ontario Provincial Standard Specifications, Material

OPSS 1003 Aggregates - Hot Mix Asphalt
OPSS 1103 Emulsified Asphalt
OPSS 1301 Cementing Materials

Ontario Ministry of Transportation Publications

MTO Laboratory Testing Manual:

LS-200 Penetration of Bituminous Materials
LS-291 Quantitative Extraction of Asphalt Cement and Mechanical Analysis of Extracted Aggregate from Bituminous Paving Mixtures - Ontario Procedure
LS-300 Preparation of Marshall Specimens for Cold In-Place Recycled Mixtures
LS-306 Bulk Relative Density of Compacted Bituminous Mixtures Using Paraffin-Coated Specimens
LS-602 Sieve Analysis of Aggregates
LS-625 Sampling of Granular Materials

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

SP-027 Manual for Assessment of Surface Defects of In-Place Recycled Pavement Mats

ASTM International

D 6752 / D 6752M -11 Standard Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Automatic Vacuum Sealing Method

333.03 DEFINITIONS

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

Active Filler means substances added to the reclaimed existing asphalt pavement that chemically alter the mix properties.

AMRL means as defined in OPSS 310.

CCIL means as defined in OPSS 310.

Cold In-Place Recycled (CIR) Mix means the in-place mixture of existing reclaimed HMA pavement, corrective aggregate or active filler or both if required, emulsified asphalt, and water.

Corrective Aggregate means virgin aggregate or reclaimed asphalt pavement (RAP) or both added to the reclaimed existing asphalt pavement to meet the CIR mix design requirements.

Hot Mix Asphalt (HMA) means as defined in OPSS 310.

Quality Assurance (QA) means as defined in OPSS 310.

Quality Control (QC) means as defined in OPSS 310.

Reclaimed Asphalt Pavement (RAP) means as defined in OPSS 310.

Segregation means a condition of the pavement characterized by areas with comparatively coarser or finer texture than that of the surrounding pavement. Longitudinal streak is segregation that manifests itself as a longitudinal mark on the pavement mat.:

- a) **Slight Segregation** means the pavement matrix is in place between the coarse aggregate particles; however, there are slightly more coarse aggregate particles in comparison with the surrounding acceptable mix.
- b) **Medium Segregation** means the pavement has significantly more coarse aggregate particles than the surrounding acceptable mat and usually exhibits some lack of surface matrix. Some coarse aggregate particle to coarse aggregate particle contact may also exist.
- c) **Severe Segregation** means the pavement appears very coarse, predominantly with coarse aggregate particle to coarse aggregate particle contact and the pavement has little or no matrix.

Target Density means the average Bulk Relative Density for the lot established according to LS-300, and used to determine the per cent Compaction.

333.04 DESIGN AND SUBMISSION REQUIREMENTS

333.04.01 Design Requirements

For mix design purposes, prior to commencing the work samples representative of the material that is

produced during the milling operation shall be obtained. These samples shall be used to establish the design rate of emulsified asphalt as a percent by mass of the RAP. The design rate of the emulsified asphalt shall be a minimum of 1.2%.

The mix design shall be completed by a laboratory with CCIL Type A certification or equivalent equipped to carry out CIR mix design. When the existing pavement significantly changes composition, a separate mix design shall be completed.

Each mix design shall include the following:

- a) Information on the type, manufacturer, and supplier of the emulsified asphalt.
- b) The percent by mass of emulsified asphalt in the CIR, referred to as the design rate, and all calculations performed to determine the design rate of the emulsified asphalt.
- c) The optimum moisture content and the mix design bulk relative density.
- d) The amount of water to be added to the mix.
- e) Maximum field rate adjustment allowed to the design rate without adverse affects to the mix properties.
- f) Recovered penetration for the binder of the existing pavement according to LS-200.
- g) Type, source, gradation, and quantity of corrective aggregate, if required.
- h) Type, source, and quantity of active filler, if required.

333.04.02 Submission Requirements

The mix design shall be submitted to the Contract Administrator a minimum of 7 Days prior to the start of CIR operations. When more than one mix design is required, the area for which each mix design is to be used shall be clearly identified.

A new mix design shall be submitted when the emulsified asphalt design rate is adjusted by greater than 0.2%. Separate or new mix designs shall be submitted if the composition or layer thicknesses or both of the existing pavement changes significantly.

333.05 MATERIALS

333.05.01 Active Filler

If required by the mix design, active filler shall be incorporated into the reclaimed existing asphalt pavement at the application rate determined by the mix design.

When used as active filler, Portland cement shall be according to OPSS 1301. No more than 1% by mass of Portland cement shall be added to the mix.

333.05.02 Corrective Aggregate

If required by the mix design, corrective aggregate shall be incorporated into the reclaimed existing asphalt pavement at the application rate determined in the mix design. Corrective aggregate shall meet the physical and consensus property requirements of OPSS 1003 for the coarse and fine aggregates of Superpave 19.0 binder course.

333.05.03 Emulsified Asphalt

Emulsified asphalt shall be mixing grade meeting the requirements of OPSS 1103, and be compatible with the process and materials used. The addition of polymer modification shall be as specified in the Contract Documents.

333.05.04 Reclaimed Asphalt Pavement

RAP material shall be 100% passing the 37.5 mm sieve and 95 to 100% passing the 26.5 m sieve after processing, as per LS-602.

333.05.05 Water

Water shall be clean and free from oil, acid, alkali, organic matter, or other deleterious substances.

333.06 EQUIPMENT

333.06.01 Recycling Train

The recycling train shall include the following:

- a) A self-propelled cold milling unit with a cutting drum capable of reclaiming a full lane width of asphalt pavement to the depth specified in the Contract Documents in one pass.
- b) A sizing unit capable of processing the RAP to meet the requirements of this specification.
- c) An aggregate feed system that measures and regulates the mass of RAP being added into the mixing unit prior to the addition of the emulsified asphalt. The scale shall be calibrated to the manufacturer's tolerance at the start of the Contract and when requested by the Contract Administrator.
- d) An emulsified asphalt control system equipped with a flow meter calibrated in litres per tonne and a total delivery meter calibrated in litres to continuously maintain the required amount of emulsified asphalt added to within 0.2% by mass of the reclaimed material feed.
- e) A means of monitoring and controlling the addition of water.
- f) A mixing unit equipped with a device capable of producing a uniform and thoroughly blended CIR mix.

Alternative equipment may be considered subject to approval by the Contract Administrator and demonstration of meeting the requirements of the Cold In-Place Recycling Trial Section subsection.

333.06.02 Placing Equipment

Placing of the CIR mix shall be carried out by means of a self-propelled mechanical paver capable of spreading the mix evenly in front of the screed in one continuous pass to the specified crossfall and grade. The paver shall be equipped with distributing augers for the full width to be paved. The paver shall have a vibratory screed capable of vibrating the full width of mix placed.

333.06.03 Compaction Equipment

Appropriate compaction equipment to achieve the required compaction shall be used.

333.06.04 Drying Unit

A drying unit specifically designed to provide radiant heat to the CIR mat may be used. Open flame heating shall not be used. The entire heater assembly shall be capable of readily adjusting the intensity of heat on the pavement surface.

333.06.05 Pilot Vehicle

The pilot vehicle shall be according to the requirements of the OTM, Book 7.

333.06.06 Straight Edge

The straight edge shall be 3 m in length, metal, and have a level recessed in its upper edge parallel to the lower edge.

333.07 CONSTRUCTION

333.07.01 General

HMA pavement in areas inaccessible to the reclaiming equipment shall be removed and replaced with acceptable binder course HMA. The HMA shall be placed to the CIR depth specified in the Contract Documents in compacted lift thicknesses between 40 and 75 mm in depth.

The overlap between successive passes of the recycling train shall be a minimum 100 mm.

333.07.02 Operational Constraints

The work shall not be carried out when the ambient temperature is less than 10 °C or when the overnight low is forecast to be less than 2 °C. CIR shall not be placed after September 1st without written approval from the Contract Administrator. The work shall be carried out when the roadway is clean and free of standing water. CIR shall not proceed in the rain.

All traffic, including construction traffic, shall be kept off the freshly placed CIR mat until it is able to carry traffic without damage. Damaged CIR mat shall be repaired.

The wearing surface shall not be placed on the CIR mat until the following requirements have been met:

- a) The CIR mat has been opened to traffic and allowed to cure for a minimum of 14 Days.
- b) The specified moisture content has been achieved according to the Acceptance Criteria for Moisture Content subsection.
- c) The specified density has been achieved according to the Compaction subsection.
- d) All defective areas in the CIR mat have been repaired to the satisfaction of the Contract Administrator.

The wearing surface shall be placed within 30 Days of placing the CIR mat. The 30 Day requirement may be waived by the Contract Administrator if the CIR mix does not meet the requirements of this specification and is subject to repair.

333.07.03 Cold In-Place Recycling Trial Section

Prior to carrying out CIR on the Contract, the ability to successfully carry out CIR according to this specification shall be demonstrated to the Contract Administrator by placing a trial section within the Contract limits.

In lieu of a trial section, the Contract Administrator may accept evidence that the Contractor has demonstrated the ability to successfully mix, handle, place, and compact CIR with the same equipment, placing crew, and methodology to meet the Contract requirements for placing CIR on any Contract within the last 12 months.

The trial section shall be one lane width and 500 m in length. The location of the trial section shall be proposed to the Contract Administrator for approval. The Contract Administrator shall be given a minimum of 48 hours' notice prior to placing the trial section.

The Contract Administrator shall allow the CIR work to continue based on an acceptable visual assessment of the trial according to the requirements of the Surface Appearance subsection. When the CIR is rejected by visual assessment, additional trial sections shall be completed until the CIR meets the requirements of this specification.

Unacceptable trial sections shall be repaired, removed, or replaced, as required.

333.07.04 Surface Preparation

When specified in the Contract Documents, milling prior to CIR work shall be carried out to achieve the specified crossfall and grade.

All deleterious and loose milled material shall be removed from the milled surfaces at longitudinal and transverse joints after reclaiming operations are completed and before placing the CIR mix.

All existing crack sealant shall be removed and disposed of prior to CIR reclaiming operations.

333.07.05 Mixing

The emulsified asphalt shall be added at the design rate. The rate of addition of emulsified asphalt shall be field adjusted as required to within 0.20% of the design rate and mixed to produce a uniformly coated CIR mix that can be compacted to the specified density. The minimum percent of emulsified asphalt added shall be 1.2%.

Water may be added in a controlled manner to facilitate uniform mixing.

333.07.06 Compaction

The CIR mix shall be compacted according to the requirements of the Acceptance Criteria for Compaction subsection.

333.07.07 Surface Appearance

The compacted CIR mat shall be smooth and shall be according to the crossfall and grade specified in the Contract Documents. The surface of the CIR mat shall be of uniform texture and shall be free of segregation, longitudinal streaks, flushing, fat spots, oil spills, roller marks, and other defects.

333.07.08 Drying

Prior to the placement of the wearing surface, a drying unit may be used. Overheating or burning of the CIR shall not be allowed.

333.07.09 Sampling

333.07.09.01 General

Holes resulting from the removal of samples shall be repaired according to the sampling provisions of OPSS 310, using acceptable binder course HMA or other material approved by the Contract Administrator.

333.07.09.02 Cold In-Place Recycling Material

At least 4 Business Days prior to the planned overlay of the CIR mat, 2 slab samples of the CIR material shall be obtained for each area taken at random locations, as directed by the Contract Administrator:

One slab sample shall be used to test for moisture content and the other shall be used to test for compaction. Each slab sample shall be dry cut 150 x 150 mm and removed intact from the CIR mat.

The samples shall be packaged in non-absorptive materials to protect sample integrity, sealed in waterproof containers, appropriately labelled, and delivered in good condition within 48 hours of sampling to the designated QA testing laboratory specified in the Contract Documents.

Additional slab samples to test for compaction and moisture content shall only be taken once remedial work has been carried out to improve compaction in the failed areas. The Contractor shall be charged the cost of additional testing.

At the start of production for each location in a Contract, or whenever the existing pavement material significantly changes composition within a location in a Contract, 15 kg of material reclaimed from the roadway after adding emulsion shall be obtained for the purpose of determining target density. Samples shall be taken at random locations as directed by the Contract Administrator.

The Contractor shall be permitted to carry out QC sampling and testing of the CIR mat.

333.07.09.03 Emulsified Asphalt

For information purposes, samples of emulsified asphalt used in the mix shall be taken at the job site from each tanker load of material used on the Contract. Each sample shall be taken either from a sampling spigot on the transfer line, if available, or from the end of the transfer line after a minimum of 4,000 kg has been drawn from the tanker. Each set of samples shall be a minimum of 2 full four-litre containers.

Samples of the emulsified asphalt used in the mix shall be obtained, properly labelled and identified, and delivered to the designated QA testing laboratory.

The sample containers supplied by the Contractor shall be new triple tight epoxy lined pails or suitable leak-proof plastic containers. The sample labels shall be obtained from the Contract Administrator.

333.07.09.04 Corrective Aggregate

The Contract Administrator may request samples of the corrective aggregate to demonstrate conformance to the requirements of this specification. When requested, two 25 kg samples shall be taken in the presence of the Contract Administrator.

QA samples shall be taken in accordance with the procedures given in LS-625 and at the time and location determined by the Contract Administrator.

Samples of the corrective aggregate shall be obtained, properly labeled and identified, and delivered within 48 hours of sampling to the designated QA testing laboratory as specified in the Contract Documents.

333.07.09.05 Active Filler

The Contract Administrator may take samples of active filler to demonstrate conformance to the requirements of this specification.

333.07.10 Traffic Convoy

Traffic shall be convoyed according to the OTM, Book 7.

The pilot vehicle shall guide one-way traffic through or around construction. The maximum speed of the convoy shall be 30 km/h. Convoying shall be maintained until such time as the CIR mat is able to carry traffic without damage.

333.07.11 Management of Excess Material

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

333.08 QUALITY ASSURANCE

333.08.01 General

Acceptance shall be based on QA testing. QA testing shall be carried out at a laboratory currently certified by CCIL with Type A or Type B certification or AMRL accredited or equivalent laboratory.

The Contract Administrator shall reject all unacceptable material and all visually defective material, mix, or work shown in Table 1. Defective material, mixture, and work shall not be incorporated into the finished work.

If the CIR does not meet the requirements of the specification within 30 Days after placing the CIR mat, it shall be deemed unacceptable.

333.08.02 Surface Tolerance

After compaction, the surface of the CIR mat shall be free from deviations exceeding 6 mm, as measured in any direction with a 3 m straight edge.

333.08.03 Acceptance Criteria for Moisture Content

Acceptance criteria shall be based on the QA test results for each location in the Contract.

The moisture content shall be determined according to LS-291. The average moisture content for each location in a Contract placed shall be 2.0% or less, with no individual test for the location exceeding 3.0%.

The CIR mix that does not meet moisture content requirements shall be deemed unacceptable.

333.08.04 Acceptance Criteria for Compaction

Acceptance criteria shall be based on the QA test results for each area represented by a set of slab samples and the Target Density established for that area.

The CIR mix shall be compacted to a minimum of 96% of the Target Density.

Compaction shall be calculated for area of CIR represented by a set of slab sample from the bulk relative density determined from slab samples according to LS-306 or ASTM D 6752 and the Target Density as follows:

Compaction = (bulk relative density of slab sample / Target Density) x 100%

The Target Density shall be established according to LS-300.

CIR that is not compacted to the required density shall be deemed unacceptable.

333.08.05 Acceptance of Corrective Aggregate

QA testing shall be carried out to ensure that corrective aggregate to be used in the work is according to the physical and consensus property requirements of OPSS 1003 for the coarse and fine aggregates of Superpave 19.0 binder course.

333.08.06 Repair of Unacceptable Cold In-Place Recycled Mat

The CIR mat that is unacceptable shall be repaired as specified in Table 1.

Repairs shall be for the full lane width and a minimum length of 15 m to the depth shown in Table 1.

The HMA required to repair unacceptable CIR shall be placed in compacted lift thickness between 40 to 75 mm.

The HMA mix type and design used for repairs shall be approved by the Contract Administrator and shall meet the acceptance requirements for the HMA specified elsewhere in the Contract Documents.

333.09 MEASUREMENT FOR PAYMENT

333.09.01 Actual Measurement

333.09.01.01 Cold In-Place Recycled Mix

Measurement of CIR placed shall be by area in square metres.

333.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

333.10 BASIS OF PAYMENT

333.10.01 Cold In-Place Recycled Mix - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

The addition of corrective aggregate or active filler to the mix shall be at no extra cost to the Owner.

HMA required to replace unacceptable CIR material shall be at no extra cost to the Owner.

Emulsified asphalt shall be included in the Cold In-Place Recycled Mix item.

Repair of an unacceptable CIR mat shall be carried out at no extra cost to the Owner.

HMA placed in areas inaccessible to the reclaiming equipment shall be included in the Cold In-Place Recycled Mix item.

Repair of areas of CIR damaged by traffic shall be completed at no extra cost to the Owner.

Repair, removal, or replacement of an unacceptable trial section shall be completed at no extra cost to the Owner.

TABLE 1
Unacceptable CIR Mix and Required Repair

Defect Type	Severity	Required Repair
Ravelling/Coarse Aggregate Loss (Note 1)	Very Slight to Slight	No action required.
	Moderate to Severe	Mill 50 mm and replace with an acceptable binder course HMA (Note 3).
	Very Severe	Remove CIR to full depth and replace with an acceptable binder course HMA (Note 3).
Segregation (Note 2)	Slight to Medium	No action required.
	Severe	Mill 50 mm and replace with an acceptable binder course HMA (Note 3).
Moisture content could not be achieved as per the Acceptance Criteria for Moisture Content subsection.	N/A	Remove CIR material to full depth represented by the test and replace with an acceptable binder course HMA (Note 3).
Compaction could not be achieved as per the Acceptance Criteria for Compaction subsection.	N/A	Remove CIR material to full depth represented by the test and replace with an acceptable binder course HMA (Note 3).
Notes: 1. Defect and severity definitions according to SP-027. 2. Defect and severity definitions according to Definitions section of this specification. 3. Reprocessing may be considered as a repair method, upon submission of a proposal by the Contractor and approved by the Contract Administrator.		

**Appendix 333-A, November 2015
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS**

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

Designer Action/Considerations

Cold in-place recycling (CIR) is suitable for treating a wide range of pavement distresses. CIR can repair pavements exhibiting age, thermal, fatigue, or reflective cracking and previously recycled pavements and is beneficial in mitigating reflective cracking. CIR is not suitable for pavements with extensive base or subbase problems, pavements containing steel slag, or pavements of insufficient strength.

The designer should specify the following in the Contract Documents:

- The addition of polymer modified may be considered to enhance additional performance (333.05.03)
- Depth of CIR. (333.07.01)
- Crossfall and grade. (333.07.07)
- Testing laboratory to carry out CIR moisture content and compaction testing. (333.07.09.02)
- Testing laboratory to carry out corrective aggregate testing. (333.07.09.04)

The designer should determine if the following is required and, if so, specify it in the Contract Documents:

- Additional items for milling or padding or both if significant crossfall deficiencies (> 1%) exist in the existing pavement surface. (333.07.04)

It is recommended that adequate pre-engineering be carried out on the project and that existing pavement thicknesses and composition be established. Additional investigation should be carried out where pavement composition changes, such as patched areas. Pre-engineering data should be included in the Contract Documents.

Corrective aggregates are used when existing pavements are experiencing rutting, shoving, or flushing and it is suspected that the existing bituminous material is the cause of these distresses. Corrective aggregate may also be required to achieve mix design properties.

Any full depth repairs required for frost heave and distortion corrections should be repaired prior to CIR.

In urban areas, the designer should be aware of appurtenance adjustment requirements, curb heights, and accessibility concerns to accommodate the CIR equipment train and the requirement for traffic detours.

Contract scheduling should allow for CIR and follow-up paving to be completed within the time, temperature, and operational constraints.

The designer should be aware that severe distresses (e.g., significant alligator cracking, map cracking) may create an abundance of oversize material and remediation (e.g., pre-milling, pre-pulverizing) that may need to be addressed to meet gradation requirements.

Appendix 333-A

The designer should be aware that the length of CIR paving operation may affect traffic management.

CIR treatment depths typically range from 75 to 125 mm. The depth of CIR treatment shall be selected to minimize disturbance of the underlying granular base. It is recommended to have at least 25 mm of remaining HMA pavement below the CIR.

CIR is typically overlaid with HMA wearing course. Surface treatment, slurry surfacing, or microsurfacing may be considered.

A tack coat is recommended prior to paving HMA wearing course.

QC requirements have been removed from this specification, as acceptance is based on QA testing. If an Owner requires Contractor QC to confirm that the work meets the specification requirements, a special provision detailing the required Contractor QC should be included in the Contract Documents.

The payment clause for this specification is all inclusive. Should a municipality desire to pay for corrective aggregate, active filler, or emulsified asphalt separately, separate payment items are required.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR COLD RECYCLED MIX

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D 334-A	Commentary

334.01 SCOPE

This specification covers the requirements for a cold mix paving process incorporating reclaimed asphalt pavement (RAP) from stockpiles. The process includes production and processing of RAP, design and testing, placement, and compaction.

334.01.01 Specification Significance and Use

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

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

334.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

334.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 310 Hot Mix Asphalt
OPSS 313 Hot Mix Asphalt - End Result

Ontario Provincial Standard Specifications, Material

OPSS 1102 Liquid Asphalt
OPSS 1103 Emulsified Asphalt

Ministry of Transportation Publications

SP-027 Manual for Assessment of Surface Defects of In-Place Recycled Pavement Mats

Field Guide for the Acceptance of Hot Mix and Bridge Deck Waterproofing

MTO Laboratory Testing Manual:

LS-291 Quantitative Extraction of Asphalt Cement and Mechanical Analysis of Extracted Aggregate from Bituminous Paving Mixtures - Ontario Procedure
LS-300 Preparation of Marshall Specimens for Cold In-Place Recycled Mixture
LS-306 Bulk Relative Density of Compacted Bituminous Mixtures Using Paraffin-Coated Specimens

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

334.03

DEFINITIONS

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

CCIL means the Canadian Council of Independent Laboratories

Cold Recycled Mix (CRM) means a mix of processed RAP and asphalt modifier produced through a cold mixing process.

Foreign matter means anything other than hot mix aggregate or granular aggregate.

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

Reclaimed Asphalt Pavement (RAP) means the processed HMA material that is recovered by partial or full-depth removal.

334.04

DESIGN AND SUBMISSION REQUIREMENTS

334.04.01

Design Requirements

Prior to commencing the work, for mix design purposes, the Contractor shall obtain RAP samples that are representative of the material to be processed. These samples shall be used to establish the design rate of the asphalt modifier as a percentage by mass of the RAP. The design rate of the asphalt modifier shall be a minimum of 1.2%.

The mix design shall be completed by a laboratory with either CCIL Type A certification or equivalent. Each mix design shall include the following:

- a) Information on the type, manufacturer, and supplier of the asphalt modifier.
- b) A copy of the mix design and all calculations performed to determine the mix design.
- c) All calculations performed to determine the design rate of asphalt modifier.
- d) Maximum field rate adjustment allowed to the design rate without adverse affects to mix properties.

334.04.02

Submission Requirements

The mix design shall be submitted to the Contract Administrator a minimum of 7 Days prior to the start of CRM operations.

A new mix design shall be submitted when the asphalt modifier design rate is adjusted by greater than 0.5%. A new mix design shall be submitted if the composition of the existing RAP changes significantly.

334.05

MATERIALS

334.05.01

Reclaimed Asphalt Pavement

The processing operation shall ensure that 100% of the RAP aggregate passes the 26.5 mm sieve. The amount of RAP aggregate passing the 75 µm sieve shall not exceed 15% by mass. Adequate measures shall be taken to manage the RAP source to ensure consistency and prevent contamination.

RAP containing steel slag or asbestos is not permitted. RAP that has become mixed with foreign matter of any description shall not be used.

334.05.02 Asphalt Modifier

The asphalt modifier shall be emulsified asphalt or liquid asphalt as specified in the Contract Documents.

Emulsified asphalt shall meet the requirements of OPSS 1103 and be either a mixing grade polymer modified high float emulsified asphalt or a mixing grade high float emulsified asphalt, as specified in the Contract Documents.

Liquid asphalt shall be according to OPSS 1102.

334.06 EQUIPMENT

334.06.01 Production and Processing Equipment

Crushing or milling equipment and screening equipment shall be used to generate and process the RAP to the size specified in the mix design. Material shall be handled in such a way as to prevent recompaction of the material before mixing takes place.

334.06.02 Mixing Equipment

The mixing unit shall be capable of producing a uniform thoroughly blended CRM consisting of RAP and asphalt modifier. The RAP feed system to the mixing unit shall be equipped with a means of determining the mass of material being deposited into the mixing unit prior to the addition of the asphalt modifier. The mixing unit shall be capable of continuously maintaining the amount of asphalt modifier added within $\pm 0.2\%$ by weight of the RAP. All measuring devices shall be calibrated according to the manufacturer's specifications at the start of the Contract and whenever deemed necessary by the Contract Administrator.

The asphalt modifier supply system shall identify and display flow and delivery information.

334.06.03 Placing Equipment

Placing of the CRM shall be carried out by means of a self-propelled mechanical paver capable of spreading the mix evenly in front of the screed in one continuous pass to the specified crossfall and grade. The paver shall be equipped with distributing augers for the full width to be paved. The paver shall have a vibratory screed capable of vibrating the full width of mix placed.

334.06.04 Compaction Equipment

The Contractor shall select the appropriate compaction equipment to achieve the required compaction.

334.06.05 Drying Unit

The drying unit shall be specifically designed to provide radiant heat to the CRM mat. Open flame heating shall not be used. The entire heater assembly shall be capable of readily adjusting the intensity of heat on the pavement surface.

334.06.06 Straight Edge

A 3 m commercially made metal straight edge is required. The straight edge shall have a level recessed in its upper surface, parallel to the lower edge.

334.06.07 Pilot Vehicle

The pilot vehicle shall be according to the requirements of the OTM, Book 7.

334.07 CONSTRUCTION

334.07.01 Operational Constraints

The placing of CRM shall not be carried out when the ambient temperature is less than 10 °C or when the overnight low is forecast to be less than 2 °C. After September 1st, written approval must be obtained from the Contract Administrator prior to CRM paving.

The work shall be carried out when the roadway is clean and free of standing water. CRM shall not proceed during periods of rain.

The wearing surface shall not be placed on the CRM mat until the following requirements have been met:

- a) The CRM mix has been allowed to cure for a minimum of 14 Days. The curing period may be shortened with the approval of the Contract Administrator.
- b) The average in situ moisture content of the CRM is 2% or less with no test value greater than 3% immediately prior to placing the wearing surface.
- c) The specified density has been achieved.
- d) All defective areas in the CRM mat have been repaired to the satisfaction of the Contract Administrator.

The wearing surface shall be placed within 30 Days of placing the CRM mat, provided the CRM mix meets the requirements of this specification.

All traffic, including construction traffic, shall be kept off the freshly placed CRM mat until it is able to carry traffic without damage. The Contractor shall be responsible for repair of the damaged CRM mat.

334.07.02 Mixing

The asphalt modifier shall be added at the design rate. The rate of addition of asphalt modifier may be adjusted as required to within 0.5% of the design rate or to the maximum field rate adjustment of the design rate allowed according to the mix design, whichever is less, to produce a uniformly coated CRM mix that can be compacted to the required density.

334.07.03 Compaction

The CRM shall be compacted to a minimum of 96% of the laboratory bulk relative density as determined by the submitted mix design, according to LS-300.

CRM that cannot be compacted to the required density shall be removed and replaced according to Table 1.

334.07.04 Surface Appearance

The compacted CRM surface shall be smooth and conform to the crossfall and grade specified in the Contract Documents. The surface of the CRM mat shall be of uniform texture and free of segregation, longitudinal streaks, fat spots, oil spills, roller marks, and other defects.

334.07.05 Drying

Prior to the placement of the wearing surface, the Contractor may elect to use a drying unit. Overheating or burning of the CRM shall not be allowed.

334.07.06 Sampling

334.07.06.01 General

The Contract Administrator may apply security seals to the samples taken for Quality Assurance (QA) testing.

All samples, including those handled by a commercial carrier, shall be accompanied by a sample data sheet and any additional documents as specified elsewhere in the Contract Documents. When not specified or not included on the sample data sheet, samples shall be delivered with a transmittal form identifying the following information:

- a) Contract Number.
- b) Name of Contractor, name of contact person and telephone numbers.
- c) Name of Contract Administrator, and telephone numbers.
- d) Quantity and type of sample. When a sample consists of more than one item, each item shall be individually identified.
- e) Date sampled.
- f) Date shipped.
- g) Sample, lot and subplot number.
- h) Sample location.

The Contractor may carry out quality control sampling and testing of the CRM mat.

Holes resulting from the removal of samples shall be repaired according to the sampling provisions of OPSS 310 or OPSS 313, as appropriate to the Contract, using surface course HMA or other material approved by the Contract Administrator.

334.07.06.02 Compaction

After initial compaction, a minimum of three samples of the compacted CRM shall be obtained by the Contractor, at random locations as determined by the Contract Administrator, for each full day or partial day of production. These samples shall be used for compaction testing.

Samples shall be removed intact from the pavement in sufficient quantities to carry out testing according to the MTO Laboratory Testing Manual.

334.07.06.03 Moisture Content

At least 4 Business Days prior to the planned overlay of the CRM mat, the Contractor shall obtain 2 slab samples of the CRM mix for each subplot taken at random locations, as directed by the Contract Administrator.

The moisture content shall be determined in accordance with LS-291. The Contractor shall test one of the duplicate samples and the other shall be delivered to the testing laboratory designated in the Contract Documents.

Each sample shall be dry cut 150 x 150 mm and removed intact from the pavement. It shall be packaged to protect sample integrity, appropriately labelled, sealed in waterproof containers, and delivered by the Contractor in good condition to the designated testing laboratory within 24 hours of sampling.

If a sample condition is found to be unsuitable for testing by the laboratory, the Contractor shall be notified immediately by the Contract Administrator to resample that location.

334.07.06.04 Asphalt Modifier

Samples of the asphalt modifier used in the mix, shall be obtained, labelled, properly identified, and delivered within 5 Business Days of sampling to the testing laboratory designated in the Contract Documents. Each sample of material shall be a minimum of 2 full four-litre containers.

Samples shall be taken at the job site from each tanker load of material. Each sample shall be taken after a minimum of 4,000 kg has been drawn from the tanker, from a sampling spigot on the transfer line, if available, or from the end of the transfer line.

The sample containers supplied by the Contractor shall be new triple tight epoxy lined pails or suitable leak-proof plastic containers. The sample labels shall be obtained from the Contract Administrator.

334.07.07 Traffic Convoy

When specified in the Contract Documents, the Contractor shall convoy traffic according to the OTM, Book 7.

The pilot vehicle shall guide one-way traffic through or around construction. The maximum speed of the convoy shall be 30 km/h. Convoying shall be maintained until such time as the CRM mat is able to carry traffic without damage.

334.07.08 Management of Excess Material

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

334.08 QUALITY ASSURANCE

334.08.01 General

The Contract Administrator shall reject all visually defective material, mix, or work according to Table 1. Such defective material, mixture, and work shall not be incorporated into the finished work.

QA testing shall be carried out at a laboratory currently certified by CCIL with Type A or Type B certification or equivalent. Samples shall be used to determine compliance for moisture content and compaction. Acceptance criteria shall be based on the lot mean computed from QA test results for each subplot within the lot.

If a tested sample fails to meet the Contract requirements, the Contractor shall be notified of the failure by the Contract Administrator within 24 hours of the Contract Administrator receiving the information.

334.08.02 Lot Size

A lot shall consist of a single day's production of CRM processed to a given mix design. Each lot shall be divided into a minimum of 3 equal sublots of 5,000 m² or smaller.

334.08.03 Surface Tolerance

After compaction, the surface of the CRM mat shall be free from deviations exceeding 6 mm, as measured in any direction with a 3 m straight edge.

334.08.04 Acceptance Criteria for Moisture Content

The moisture content shall be determined according to LS-291. The mean moisture content for each lot shall be less than 2.0% with no subplot moisture content exceeding 3.0%.

334.08.05 Acceptance Criteria for Compaction

The compaction of the CRM mix shall be determined according to LS-306. Each lot of CRM mix shall be compacted to a minimum mean of 96.0% of the target density established for the mix with no subplot result falling below 95.0%.

334.08.06 Asphalt Modifier

The supplied emulsified asphalt samples shall be according to OPSS 1103 for the particular type and grade, when tested according to the test methods specified.

The supplied liquid asphalt samples shall meet the requirements of OPSS 1102 for the particular type and grade, when tested according to the test methods specified.

Failure of the sample to conform to any of the material requirements shall be cause for rejection of the material. The CRM that has incorporated asphalt modifier represented by the failed test result shall be unacceptable and remedial measures up to and including removal and replacement of the deficient mix shall be negotiated with the Contract Administrator.

334.08.07 Repair of Unacceptable Cold Recycled Mix Mat

The CRM mat that is unacceptable shall be repaired or removed and replaced as specified in Table 1. Repairs shall be for the full width of recycling to the depth specified in Table 1. Removal shall be for the full depth and lane width of recycling. Reprocessing may be considered as a repair method, upon submission of a proposal by the Contractor and approval by the Contract Administrator.

334.09 MEASUREMENT FOR PAYMENT**334.09.01 Actual Measurement****334.09.01.01 Cold Recycled Mix**

Measurement of the CRM placed shall be by area in square metres.

334.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clause under Actual Measurement.

334.10**BASIS OF PAYMENT****334.10.01****Cold Recycled Mix - Item**

Payment at the Contract price for the above items shall be full compensation for all labour, Equipment, and Material to do the work.

Asphalt modifier is included in the cold recycled mix item.

Samples found to be unsuitable for testing upon delivery to the laboratory shall be resampled at no cost to the Owner.

Repair to or removal and replacement of unacceptable CRM mat shall be carried out at no cost to the Owner.

HMA required to replace unacceptable CRM material shall be at no cost to the Owner.

TABLE 1
Unacceptable CRM Mix and Required Repairs

Deficiency Type	Severity	Required Repair
Ravelling/Coarse Aggregate Loss (Note 1)	Very Slight to Slight	No action required.
	Moderate to Severe	Mill 50 mm and replace with same HMA to be used on surface course or an acceptable HMA as specified in the Contract Documents.
	Very Severe	Remove all CRM material and replace with same HMA to be used on surface course or an acceptable HMA as specified in the Contract Documents.
Segregation (Note 2)	Slight to Medium	No action required.
	Severe	Mill 50 mm and replace with same HMA to be used on surface course or an acceptable HMA as specified in the Contract Documents.
Moisture content could not be achieved as per the Acceptance Criteria for Moisture Content subsection.	N/A	Remove all CRM material in the subplot represented by the test and replace with CRM or the same HMA to be used on surface course or an acceptable HMA as specified in the Contract Documents.
Compaction could not be achieved as per the Acceptance Criteria for Compaction subsection.	N/A	Remove all CRM material in the subplot represented by the test and replace with CRM or the same HMA to be used on surface course or an acceptable HMA as specified in the Contract Documents.
Notes: 1. Deficiency and severity definitions according to SP-027. 2. Deficiency and severity definitions according to Field Guide for the Acceptance of Hot Mix and Bridge Deck Waterproofing. A. The HMA shall be placed in compacted lift thicknesses between 40 and 75 mm.		

Appendix 334-A, November 2016 FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

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

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Type of asphalt modifier (i.e., emulsified asphalt or liquid asphalt modifier). (334.05.02)
- Type of wearing surface. (334.07.01)
- Crossfall and grade. (334.07.04)
- Location of testing laboratory. (337.07.06.01, 334.07.06.02, 334.07.06.03, 334.07.06.04)
- Replacement HMA to be used. (334.08.07)

The designer should determine if the following is required and, if so, specify it in the Contract Documents:

- The emulsified asphalt as either a mixing grade polymer modified high float emulsified asphalt or a mixing grade high float emulsified asphalt. (334.05.02)
- Traffic convoy requirements. (334.07.07)

CRM can be a cost-effective paving material for structural improvement of low volume roads.

CRM is susceptible to moisture intrusion and ravelling, and must be sealed with a wearing surface. Typically, cold recycled mix is overlain with a surface treatment or single lift hot mix overlay. For higher traffic volume application, multiple lifts of hot mix may be considered.

Designer should be aware of when setting up quantities, due to the variability of RAP, field adjustment of the quantity of asphalt modifier may be required.

Currently, there is no standardized mix design methodology for CRM.

Designer should address the issue of RAP ownership and quality of RAP during the preparation of contract specifications. Identify who owns the RAP and who is responsible for RAP quality.

CRM contracts should be tendered to allow for placement in warm summer months to achieve proper curing of the CRM mat.

A single contract incorporating placement of CRM and wearing surface is recommended.

Since payment for the CRM is by the square metre, the designer should ensure that grade preparation is part of the CRM contract.

A tack coat is recommended prior to surfacing CRM with HMA.

When specifying liquid asphalts, the designer should consider the environmental aspects of the product.

Appendix 334-A

Contract scheduling should allow for CRM paving and follow-up wearing surface placement to be completed within the time and temperature operational constraints.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here



CONSTRUCTION SPECIFICATION FOR COLD IN-PLACE RECYCLED EXPANDED ASPHALT MIX

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APPENDICES

335-A	Commentary

335.01 SCOPE

This specification covers the requirements for cold in-place recycling of existing hot mix asphalt (HMA) pavement; sizing; adding corrective aggregate or active filler or both, if required; adding and mixing expanded asphalt; and spreading and compacting the cold in-place recycled expanded asphalt mix (CIREAM).

335.01.01 Specification Significance and Use

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

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

335.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

335.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 310 Hot Mix Asphalt

Ontario Provincial Standard Specifications, Material

OPSS 1003 Aggregates - Hot Mix Asphalt
OPSS 1101 Performance Graded Asphalt Cement
OPSS 1301 Cementing Materials

Ontario Ministry of Transportation Publications

MTO Laboratory Testing Manual:

LS-200 Penetration of Bituminous Materials
LS-297 Determination of Indirect Tensile Strength of Expanded Asphalt Mixes
LS-306 Bulk Relative Density of Compacted Bituminous Mixtures Using Paraffin-Coated Specimens
LS-625 Sampling of Granular Materials
SP-027 Manual for Assessment of Surface Defects of In-Place Recycled Pavement Mats

Ontario Traffic Manual (OTM):

Book 7 - Temporary Conditions

ASTM International

D 6752-09 Standard Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Automatic Vacuum Sealing Method

Wirtgen GmbH Publication

Wirtgen Cold Recycling Technology manual, 3rd edition, 2010

335.03 DEFINITIONS

For the purpose of this specification, definitions shall be as per SP-027.

335.04 DESIGN AND SUBMISSION REQUIREMENTS

335.04.01 Design Requirements

For mix design purposes, prior to commencing the work the Contractor shall obtain samples representative of the material that is produced during the milling operation. These samples shall be used to establish the design rate of expanded asphalt as a percent by mass of the RAP. The design rate of the expanded asphalt shall be a minimum of 1.0%. The dry tensile strength shall be a minimum of 225 kPa and the wet tensile strength shall be a minimum of 100 kPa. The tensile strength ratio shall be a minimum of 50%.

The mix design shall be carried out according to the Wirtgen Cold Recycling Technology manual using briquettes produced according to LS-297. Mix design work shall be completed by a laboratory with CCIL Type A certification or equivalent equipped to carry out expanded asphalt mix design. When the existing pavement significantly changes composition, a separate mix design shall be completed.

Each mix design shall include the following:

- a) Information on the grade, manufacturer, and supplier of the PGAC.
- b) The percent by mass of expanded asphalt in the CIREAM, referred to as the design rate, and all calculations performed to determine the design rate of the expanded asphalt.
- c) The recommended PGAC temperature for foaming, the half life, the expansion ratio, and the percent of water added for foaming.
- d) The optimum moisture content and the mix design bulk relative density.
- e) The dry tensile strength, the wet tensile strength, and the tensile strength ratio.
- f) The amount of water to be added to the mix.
- g) Maximum field rate adjustment allowed to the design rate without adverse affects to the mix properties.
- h) Recovered penetration for the binder of the existing pavement according to LS-200.
- i) Type, source, gradation, and quantity of corrective aggregate, if required.
- j) Type, source, and quantity of active filler, if required.

335.04.02 Submission Requirements

The mix design shall be submitted by the Contractor to the Contract Administrator a minimum of 7 Days prior to the start of CIREAM operations. When more than one mix design is required, the area for which each mix design is to be used shall be clearly identified.

A new mix design shall be submitted when the expanded asphalt design rate is adjusted by greater than 0.2%. Separate or new mix designs shall be submitted if the composition or layer thicknesses or both of the existing pavement changes significantly.

335.05 MATERIALS

335.05.01 Active Filler

If required by the mix design, active filler shall be incorporated into the reclaimed existing asphalt pavement at the application rate determined by the mix design.

When used as active filler, Portland cement shall be according to OPSS 1301. No more than one percent by mass of Portland cement shall be added to the mix.

335.05.02 Corrective Aggregate

If required by the mix design, corrective aggregate shall be incorporated into the reclaimed existing asphalt pavement at the application rate determined in the mix design. Corrective aggregate shall meet the physical and consensus property requirements of OPSS 1003, with the exception of the sand equivalent test, for the coarse and fine aggregates of Superpave 19.0 binder course.

335.05.03 Performance Graded Asphalt Cement

The Contractor shall select a PGAC with suitable expansion characteristics. PGAC shall be according to OPSS 1101, excluding PGAC zone requirements.

335.05.04 Reclaimed Asphalt Pavement

RAP material shall be 100% passing the 37.5 mm sieve and 95 to 100% passing the 26.5 mm sieve after processing.

335.05.05 Water

Water shall be clean and free from oil, acid, alkali, organic matter, or other deleterious substances.

335.06 EQUIPMENT

335.06.01 Recycling Train

The recycling train shall include the following:

- a) A self-propelled cold milling unit with a cutting drum capable of reclaiming a full lane width of asphalt pavement to the depth specified in the Contract Documents in one pass.
- b) A sizing unit capable of processing the RAP to meet the requirements of this specification.

- c) An aggregate feed system that measures and regulates the mass of RAP being added into the mixing unit prior to the addition of the expanded asphalt. The scale shall be calibrated to the manufacturer's tolerance at the start of the Contract and when requested by the Contract Administrator.
- d) An asphalt cement expansion system capable of producing optimum expansion and an injection system capable of injecting and blending expanded asphalt uniformly throughout the reclaimed material.
- e) A system to control and regulate the application of expanded asphalt in relation to the mass of RAP being processed within a tolerance of $\pm 3.0\%$ by volume of asphalt cement.
- f) A mixing unit equipped with a device capable of producing a uniform and thoroughly blended CIREAM.

Alternative equipment may be considered subject to approval by the Contract Administrator and demonstration of meeting the requirements of the Cold In-Place Recycled Expanded Asphalt Trial Section subsection.

335.06.02 Placing Equipment

Placing of the CIREAM shall be carried out by means of a self-propelled mechanical paver capable of spreading the mix evenly in front of the screed in one continuous pass to the specified crossfall and grade. The paver shall be equipped with distributing augers for the full width to be paved. The paver shall have a vibratory screed capable of vibrating the full width of mix placed.

335.06.03 Compaction Equipment

The Contractor shall select the appropriate compaction equipment to achieve the required compaction.

335.06.04 Pilot Vehicle

The pilot vehicle shall be according to the requirements of the OTM, Book 7.

335.06.05 Straight Edge

The straight edge shall be 3 m in length, metal, and have a level recessed in its upper edge parallel to the lower edge.

335.07 CONSTRUCTION

335.07.01 General

HMA pavement in areas inaccessible to the reclaiming equipment shall be removed and replaced with acceptable binder course HMA. The HMA shall be placed to the CIREAM depth specified in the Contract Documents in compacted lift thicknesses between 40 and 75 mm in depth.

The overlap between successive passes of the recycling train shall be a minimum 100 mm.

335.07.02 Operational Constraints

CIREAM shall not be placed after September 1st without written approval from the Contract Administrator.

The work shall be carried out when the roadway is clean and free of standing water. CIREAM shall not proceed in the rain.

All traffic, including construction traffic, shall be kept off the freshly placed CIREAM mat until it is able to carry traffic without damage. The Contractor shall be responsible for repair of the damaged CIREAM mat.

The wearing surface shall not be placed on the CIREAM mat until the following requirements have been met:

- a) The CIREAM mat has been opened to traffic and allowed to cure for a minimum of 3 Days.
- b) The specified tensile strength has been achieved according to the Quality Assurance section.
- c) The specified density has been achieved according to the Compaction subsection.
- d) All defective areas in the CIREAM mat have been repaired to the satisfaction of the Contract Administrator.

The wearing surface shall be placed within 30 Days of placing the CIREAM mat. The 30 Day requirement may be waived by the Contract Administrator if the CIREAM does not meet the requirements of this specification and is subject to repair.

335.07.03 Cold In-Place Recycled Expanded Asphalt Trial Section

Prior to carrying out CIREAM on the Contract, the Contractor shall demonstrate to the Contract Administrator the ability to successfully carry out CIREAM according to this specification by placing a trial section within the Contract limits.

In-lieu of a trial section, the Contract Administrator may accept evidence that the Contractor has demonstrated the ability to successfully mix, handle, place, and compact CIREAM with the same equipment, placing crew, and methodology to meet the Contract requirements for placing CIREAM on any Contract within the last 12 months.

The trial section shall be one lane width and 500 m in length. The Contractor shall propose the location of the trial section to the Contract Administrator for approval. The Contractor shall give the Contract Administrator a minimum of 48 hours notice prior to placing the trial section.

The Contract Administrator shall allow the Contractor to continue the CIREAM work based on an acceptable visual assessment of the trial according to the requirements of the Surface Appearance subsection. When the CIREAM is rejected by visual assessment, the Contractor shall repeat additional trial sections until the CIREAM meets the requirements of this specification.

The Contractor shall be responsible for the repair, removal, or replacement of an unacceptable trial section.

335.07.04 Surface Preparation

When specified in the Contract Documents, milling prior to CIREAM work shall be carried out to achieve the specified crossfall and grade.

All deleterious and loose milled material shall be removed from the milled surfaces at longitudinal and transverse joints after reclaiming operations are completed and before placing CIREAM.

All existing crack sealant shall be removed and disposed of prior to CIREAM reclaiming operations.

335.07.05 Mixing

The expanded asphalt shall be added at the design rate. The rate of addition of expanded asphalt shall be field adjusted as required to within 0.20% of the design rate and mixed to produce a uniformly coated

CIREAM that can be compacted to the specified density. The minimum percent of expanded asphalt added shall be 1.0%.

335.07.06 Compaction

The CIREAM shall be compacted according to the requirements of the Acceptance Criteria for Compaction subsection.

335.07.07 Surface Appearance

The compacted CIREAM mat shall be smooth and shall be according to the crossfall and grade specified in the Contract Documents. The surface of the CIREAM mat shall be of uniform texture and shall be free of segregation, longitudinal streaks, flushing, fat spots, oil spills, roller marks, and other defects.

335.07.08 Sampling

335.07.08.01 General

Holes resulting from the removal of samples shall be repaired according to the sampling provisions of OPSS 310, using an acceptable binder course HMA or other material approved by the Contract Administrator.

335.07.08.02 Cold In-Place Recycled Expanded Asphalt Mix

After placement and prior to compaction, the Contractor shall obtain one 15 kg sample of the CIREAM from each 5,000 m² placed, taken at random locations as directed by the Contract Administrator. The samples to be tested for acceptance of CIREAM shall be used to test for dry tensile strength, wet tensile strength, and tensile strength ratio according to LS-297.

Prior to the planned overlay of the CIREAM mat, the Contractor shall obtain 2 slab samples of the CIREAM from each 5,000 m² placed, to be taken at random locations as directed by the Contract Administrator. One slab sample shall be used to test for moisture content and the other shall be used to test for compaction. Each slab sample shall be dry cut 150 x 150 mm and removed intact from the CIREAM mat.

The samples shall be packaged in non-absorptive materials to protect sample integrity, sealed in waterproof containers, appropriately labelled, and delivered by the Contractor in good condition within 48 hours of sampling to the designated QA testing laboratory specified in the Contract Documents.

Additional slab samples to test for compaction shall only be taken once the Contractor has carried out remedial work to improve compaction in the failed areas. The Contractor shall be charged the cost of additional testing.

The Contractor shall be permitted to carry out QC sampling and testing of the CIREAM mat.

335.07.08.03 Corrective Aggregate

The Contract Administrator may request samples of the corrective aggregate to demonstrate conformance to the requirements of this specification. When requested, two 25 kg samples shall be taken in the presence of the Contract Administrator.

QA samples shall be taken in accordance with procedures given in LS-625 and at the time and location determined by the Contract Administrator.

Samples of the corrective aggregate shall be obtained, properly labelled and identified, and delivered within 48 hours of sampling to the designated QA testing laboratory as specified in the Contract Documents.

335.07.08.04 Active Filler

The Contract Administrator may take samples of active filler to demonstrate conformance to the requirements of the Contract Documents.

335.07.09 Traffic Convoy

The Contractor shall convoy traffic according to the OTM, Book 7.

The pilot vehicle shall guide one-way traffic through or around construction. The maximum speed of the convoy shall be 30 km/h. Convoying shall be maintained until such time as the CIREAM mat is able to carry traffic without damage.

335.07.10 Management of Excess Material

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

335.08 QUALITY ASSURANCE

335.08.01 General

Acceptance shall be based on QA testing. QA testing shall be carried out by a laboratory currently certified by CCIL with Type A or Type B certification or AMRL accredited or equivalent laboratory.

Acceptance criteria shall be based on the QA test results for each 5,000 m² placed.

The Contract Administrator shall reject all unacceptable material and all visually defective-material, mix, or work as shown in Table 1. Defective material, mixture, and work shall not be incorporated into the finished work.

If the CIREAM does not meet the requirements of the specification within 30 Days after placing the CIREAM mat, it shall be deemed unacceptable.

335.08.02 Surface Tolerance

After compaction, the surface of the CIREAM mat shall be free from deviations exceeding 6 mm, as measured in any direction with a 3 m straight edge.

335.08.03 Acceptance Criteria for Compaction

The CIREAM shall be compacted to a minimum of 96% of the target density.

Compaction shall be calculated for each 5,000 m² placed from the bulk relative density determined from slab samples according to LS-306 or ASTM D 6752 and the target density as follows:

Compaction = (bulk relative density of the slab sample / target density) x 100%

The target density to be used for acceptance purposes shall be calculated for each 5,000 m² placed by averaging the densities of 6 compacted specimens produced for indirect tensile strength testing according to LS-297.

335.08.04 Acceptance Criteria for Cold In-Place Recycled Expanded Asphalt Mix

Acceptance of the CIREAM shall be based on dry tensile strength, wet tensile strength, and tensile strength ratio.

Samples of CIREAM shall be tested for acceptance purposes in accordance with LS-297.

Dry tensile strength requirements for each 5,000 m² placed are met when the dry tensile strength of the sample is equal to or greater than 225 kPa.

Wet tensile strength requirements for each 5,000 m² placed are met when the wet tensile strength of the sample is equal to or greater than 100 kPa.

The tensile strength ratio for the individual samples shall not be less than 50%.

CIREAM that does not meet the above dry tensile strength, wet tensile strength, and tensile strength ratio requirements shall be deemed unacceptable.

335.08.05 Acceptance of Corrective Aggregate

QA testing may be carried out to ensure that corrective aggregate to be used in the work is according to the physical and consensus property requirements of OPSS 1003, with the exception of the sand equivalent test, for the coarse and fine aggregates of Superpave 19.0 binder course.

335.08.06 Repair of Unacceptable CIREAM

CIREAM that is unacceptable shall be repaired as shown in Table 1.

Repairs shall be for the full lane width and minimum length of 15 m to the depth shown in Table 1.

The HMA required to repair unacceptable CIREAM shall be placed in compacted lift thickness between 40 to 75 mm.

The HMA mix type and design used for repairs shall be approved by the Contract Administrator and shall meet the acceptance requirements for the HMA specified elsewhere in the Contract Documents.

335.09 MEASUREMENT FOR PAYMENT

335.09.01 Actual Measurement

335.09.01.01 Cold In-Place Recycled Expanded Asphalt Mix

Measurement of CIREAM placed shall be by area in square metres.

335.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

335.10 BASIS OF PAYMENT

335.10.01 Cold In-Place Recycled Expanded Asphalt Mix - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour,

Equipment, and Material to do the work.

The addition of corrective aggregate or active filler to the mix shall be at no extra cost to the Owner.

HMA required to replace unacceptable CIREAM material shall be at no extra cost to the Owner.

PGAC shall be included in the CIREAM item.

Repair of unacceptable CIREAM mat shall be carried at no extra cost to the Owner.

HMA placed in areas inaccessible to the reclaiming equipment shall be included in the CIREAM item.

Repair of areas of CIREAM damaged by traffic shall be completed at no extra cost to the Owner.

Repair, removal, or replacement of an unacceptable trial section shall be completed at no extra cost to the Owner.

TABLE 1
Acceptance Criteria and Repair Requirements for CIREAM

Acceptance Criteria	Defect Type	Severity / Criteria	Acceptable / Rejectable	Repair Requirements
Surface Appearance	Ravelling/Coarse Aggregate Loss (Note 1)	Very Slight to Slight	Acceptable	No action required.
		Moderate to Severe	Rejectable	Mill 50 mm and replace with an acceptable binder course HMA (Note 2).
		Very Severe	Rejectable	Remove CIREAM to full depth and replace with an acceptable binder course HMA (Note 2).
	Segregation (Note 1)	Slight to Medium	Acceptable	No action required.
		Severe	Rejectable	Mill 50 mm and replace with an acceptable binder course HMA (Note 2).
	Rutting (Note 1)	Very Slight to Slight	Acceptable	No action required.
		Moderate to Severe	Rejectable	Mill 50 mm and replace with an acceptable binder course HMA (Note 2).
		Very Severe	Rejectable	Remove CIREAM to full depth and replace with an acceptable binder course HMA (Note 2).
Surface Tolerance	Non-conformance for surface tolerance as per the Surface Tolerance subsection of the Acceptance Criteria.	> 6 mm based on 3 m straight edge measurement	Rejectable	All deficient areas shall be re-profiled by milling or padded with the same hot mix type to be used in the overlying hot mix lift.
Compaction	Non-conformance for Compaction as per the Compaction subsection of the Acceptance Criteria.	< 96% for Compaction of Lot's Mean; and < 95% for Compaction of Individual Sublot	Rejectable	For rejected sublots, or sublots within the corresponding rejected lot: 1) Recompact the CIREAM mat, if required, with reheating process, or 2) Reprocess with a recycling train (Note 2), or 3) Remove CIREAM material to full depth and replace with an acceptable binder course HMA.
Tensile Strength	Non-conformance for Tensile Strength as per the Tensile Strength of Cold In-place Recycled Expanded Asphalt Mix subsection of the Acceptance Criteria.	For Dry Tensile Strength: < 225 KPa for Lot's Mean; and < 200 KPa for Individual Sublot. For Wet Tensile Strength: < 100 KPa for Lot's Mean; and < 75 KPa for Individual Sublot.	Rejectable	Remove CIREAM to full depth in the lot or sublot represented by the test and replace with an acceptable binder course HMA (Note 2).
Notes: 1) Defect and severity definitions according to SP-027. 2) Reprocessing with a recycling train may be considered as a repair method, upon submission of a proposal by the Contractor and approved by the Contract Administrator.				

Appendix 335-A, Commentary for OPSS.MUNI 335, November 2016 FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

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

Designer Action/Considerations

Cold in-place recycling with expanded asphalt (CIREAM) is suitable for treating a wide range of pavement distresses. CIREAM can repair pavements exhibiting age; thermal, fatigue, or reflective cracking and previously recycled pavements and is beneficial in mitigating reflective cracking. CIREAM is not suitable for pavements with extensive base or subbase problems, pavements containing steel slag, or pavements of insufficient strength.

The designer should specify the following in the Contract Documents:

- Depth of CIREAM. (335.07.01)
- Grade and crossfall. (335.07.07)
- Designated testing laboratory. (335.07.08.02, 335.07.08.03)

The designer should determine if the following is required and, if so, specify it in the Contract Documents:

- Additional items for milling or padding or both if significant crossfall deficiencies exist in the existing pavement surface. (335.07.04)

It is recommended that adequate pre-engineering be carried out on the project and that existing pavement thicknesses and composition be established. Additional investigation should be carried out when pavement composition changes, such as patched areas. Pre-engineering data should be included in the Contract Documents.

Corrective aggregates are used when existing pavements are experiencing rutting, shoving, or flushing and it is suspected that the existing bituminous material is the cause of these distresses. Corrective aggregate may also be required to achieve mix design properties.

Any full depth repairs required for frost heave and distortion corrections should be repaired prior to CIREAM.

In urban areas, the designer should be aware of appurtenance adjustment requirements, curb heights, and accessibility concerns to accommodate the CIREAM equipment train and the requirement for traffic detours.

Contract scheduling should allow CIREAM and follow-up pavement to be completed within the time and operational constraints.

The designer should be aware that severe distresses (e.g., significant alligator cracking, map cracking) may create an abundance of oversize material and remediation (e.g., pre-milling, pre-pulverizing) needs to be addressed to meet gradation requirements.

The designer should be aware that the length of CIREAM paving operation may affect traffic management.

Appendix 335-A

It is recommended to have at least 25 mm of remaining HMA pavement below the CIREAM.

CIREAM is typically overlaid with a HMA wearing course. Surface treatment, slurry surfacing, or microsurfacing may be considered.

A tack coat is recommended prior to paving HMA wearing course.

QC requirements have been removed from this specification, as acceptance is based on QA testing. If an Owner requires Contractor QC to confirm that the work meets the specification requirements, a special provision detailing the required Contractor QC should be included in the Contract Documents.

The payment clause for this specification is all inclusive. Should a municipality desire to pay for corrective aggregate, active filler, or asphalt cement separately, separate payment items are required.

In times of volatile asphalt cement prices, on multi-year contracts, and on Contracts with greater than 1,000 tonnes of paver laid CIREAM material, designers may consider using the MTO PGAC price index for payment adjustment. The MTO PGAC price index is available on the Ontario Ministry of Transportation website at www.raqs.mto.gov.on.ca, by clicking on Contractor, Contract Bulletin, Asphalt Price Index. The MTO PGAC price index is only a tool for qualifying PGAC prices and is not intended as a standard asphalt cement price to be incorporated into the contract bid. The MTO PGAC price index calculation for a given month takes in the average of the 4 weeks of the month and is published on the last day of the month.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR CONCRETE CURB AND GUTTER SYSTEMS

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353.01 SCOPE

This specification covers the requirements for the construction of concrete curb and gutter, setbacks, gutter outlets, and bullnoses together with the installation of catch basin frames and grates which lie within the flow lines of the curb and gutter system.

353.01.01 Specification Significance and Use

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

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

353.01.02

Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

353.02

REFERENCES

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 206	Grading
OPSS 314	Untreated Granular Subbase, Base, Surface Shoulder, and Stockpiling
OPSS 350	Concrete Pavement and Concrete Base
OPSS 407	Construction of Maintenance Hole, Catch Basin, Ditch Inlet, and Valve Chamber Installation
OPSS 501	Compacting
OPSS 904	Concrete Structures
OPSS 905	Steel Reinforcement for Concrete
OPSS 919	Formwork and Falsework

Ontario Provincial Standard Specifications, Material

OPSS 1212	Hot Poured Rubberized Asphalt Joint Sealing Compound
OPSS 1308	Joint Filler in Concrete
OPSS 1315	White Pigmented Curing Compounds for Concrete
OPSS 1350	Concrete - Materials and Production
OPSS 1440	Steel Reinforcement for Concrete
OPSS 1850	Frames, Grates, Covers, and Gratings

353.03 DEFINITIONS

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

Cold Joint means as defined in OPSS 904

Concrete Pavement means concrete pavement or concrete base.

Curb and Gutter means curb, gutter, or combinations of curb and gutter.

Curb and Gutter Systems means curb and gutter, setbacks, gutter outlets, concrete spillways, bullnoses, or any combination of them.

353.05 MATERIALS

353.05.01 Concrete

Concrete shall be according to OPSS 1350. Concrete shall also be according to the following requirements:

- a) Minimum specified 28-Day compressive strength: 30 MPa

Concrete shall also be according to the following requirements:

- a) Coarse Aggregate: 19.0 mm nominal maximum size
- b) When used supplementary cementing material shall be ground granulated blast furnace slag or fly ash or a combination of the two materials and shall be restricted to the following proportions by mass of the total cementing material:
 - 1) Slag up to 25%; or
 - 2) Fly ash up to 10%, or
 - 3) A mixture of slag and fly ash up to 25% except the amount of fly ash shall not exceed 10% by mass of the total cementing materials.

353.05.02 Catch Basin Frames and Grates

Catch basin frames and grates shall be according to OPSS 1850.

353.05.03 Joint Materials

Expansion joint fillers shall be according to OPSS 1308 for types A or B except that granulated cork fillers shall not be accepted.

Hot rubberized asphalt joint sealing compound shall be according to OPSS 1212.

353.05.04 Curing Compound

Curing compound shall be according to OPSS 1315.

353.05.05 Forms

Forms shall be according to OPSS 919.

353.05.06 Steel Reinforcement

Steel reinforcement shall be according to OPSS 1440.

353.07 CONSTRUCTION

353.07.01 General

The Construction section applies equally to concrete curb and gutter, concrete spillways, and concrete gutter outlets.

353.07.02 Foundation and Backfill

Excavation and embankment construction shall be according to OPSS 206.

Granular base and granular backfill construction shall be according to OPSS 314.

353.07.03 Compaction

Compaction shall be according to OPSS 501.

353.07.04 Steel Reinforcement

Placement of steel reinforcement shall be according to OPSS 905.

353.07.05 Formwork

Formwork shall be according to OPSS 919 and shall be set true to the lines and grades specified in the Contract Documents and in direct contact with the subgrade or granular course.

353.07.06 Slipform

Slipform paving equipment is acceptable for use provided the slipform product meets the specified cross-sectional requirements.

353.07.07 Joints

When concrete curb and gutter is constructed adjacent to concrete pavement, the transverse joint spacing of the curb and gutter shall coincide with that of the concrete pavement. When concrete curb and gutter is constructed adjacent to asphalt pavement, transverse joints shall have a uniform spacing not exceeding 5 m. In addition to the foregoing, joints shall be constructed between the curb structure, including catch basin frames, setbacks, and gutter outlets.

Joints, including those between curb and gutter systems and any abutting sidewalk, catch basin frames, setbacks, gutter outlets, or any structure, shall be formed with 12 mm thick panels of joint filler except as follows:

- a) Contraction joints in extruded curb and gutter and in formed curb and gutter shall be saw cut.
- b) Longitudinal joints, as shown in the Contract Documents, shall be sawn between a curb and gutter system and concrete pavement and shall be according to OPSS 350, when the curb and gutter

system is placed adjacent to the concrete pavement. The joint shall be sealed with liquid joint sealer and shall be according to OPSS 350.

Joint filler panels shall be set in a vertical position and, if for transverse joints, shall be set normal to the inside edge of the structure.

Panels shall be precut from a single piece of joint filler to the shape of the curb and gutter cross-section as shown in the Contract Documents, but so as to provide a 6 mm recess on the exposed surfaces. Cutting and tolerances shall be according to OPSS 1308.

Expansion joint material shall be set in place before concrete placement begins and shall be supported by removable forms.

All concrete immediately above the filler material shall be carefully removed to form a 6 mm deep, 12 mm wide recess then finishing both edges of each joint to 5 mm radius with a suitable short edging tool.

Contraction joints shall be formed within a sufficient time of placing of the curb and gutter to prevent uncontrolled cracking. The width of the joint shall be 3 to 5 mm and a minimum depth of 65 mm.

353.07.08 Concrete

353.07.08.01 Placement of Concrete

Concrete shall not be placed until the base course, on which the concrete is to be placed, and the forms or stringline have been inspected by the Contract Administrator.

Before placing concrete, the subgrade immediately ahead of the concrete placing shall be wetted by means of a uniform spray of water sufficient to wet the subgrade thoroughly without leaving standing water.

The concrete shall be placed and consolidated such that segregation of the aggregate does not occur.

Concrete shall be placed continuously. If placement of concrete is interrupted, recommencement of the placement operation shall be against a vertical formed joint. A 5mm bituminous fibre joint filler shall be placed at the point of interruption before recommencing placement of concrete. Cold joints shall not be permitted.

The concrete shall be thoroughly consolidated against all formwork and all entrapped air shall be eliminated.

353.07.08.02 Concrete Finishing

The concrete on the upper surfaces shall be floated to a smooth uniform finish of the required cross-section, free of open texturing, plucked aggregate, and local projections. Only hardwood or magnesium trowels shall be used for hand finishing.

Care shall be taken to avoid over finishing or working more mortar to the surface than is actually required. Back edges shall be rounded by use of a 5 mm radius edging tool. Neat cement shall not be used as a drier to facilitate finishing.

Any honeycombed areas occurring along the formed surfaces shall be filled with mortar composed of one part Portland cement and two parts sand with 12% of entrained air.

353.07.08.03 Concrete Curing

Formed and slipformed concrete shall be cured with one or more of the following methods:

- a) Burlap and water.
- b) Moisture vapour barrier.
- c) White pigmented curing compound.

For curing with burlap and water, the burlap shall be presoaked by immersing it in water for a period of 24 hours immediately prior to placing it. Two layers of burlap shall be applied to the surface of the concrete. Strips of burlap shall overlap 150 mm and shall be held down without marring the surface of the concrete. The burlap shall be applied immediately after finishing of the concrete surface, from 2 to 4 m from the finishing operation. The burlap shall be maintained continuously in a wet condition throughout the 96-hour curing period. The burlap shall be covered with a layer of moisture vapour barrier in a manner which 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 in conformance with the requirements of curing with moisture vapour barrier. The moisture vapour barrier shall be placed within 12 hours following placement of the concrete.

For curing with only a moisture vapour barrier, the moisture vapour barrier shall be placed immediately after finishing of the concrete surface, from 2 to 4 m from the finishing operation. Strips of moisture vapour barrier shall overlap a minimum of 150 mm. Air flow in the space between the moisture vapour barrier and the concrete surface shall be prevented. To achieve this, the moisture vapour barrier shall be held down at the edges and at all laps to prevent displacement. The material shall be kept in place for a minimum curing period of 96 hours.

Curing with curing compound shall not be used on any construction joint or when cold weather concreting is in effect.

The curing compound shall be agitated by mechanical means to provide a homogeneous mixture immediately prior to application. It shall be applied immediately after finishing of the concrete surface, from 2 to 4 m from the finishing operation, completely covering the surface of the concrete. A second application of curing compound shall be applied within 30 to 60 minutes after the first application. Each application shall be such that the membrane formed is uniform in thickness and colour and free of breaks and pinholes. The surface shall be maintained in this condition for a minimum period of 7 Days. The rate of each application shall not be less than the rate specified by the manufacturer of the compound.

353.07.08.04 Concrete Tolerances

The exposed surfaces of the finished concrete shall be such that, when tested with a 3 m long straight edge placed anywhere along the surface parallel to the edge of curb face, there shall be no deviation greater than 3 mm between the bottom of the straight edge and the surface of the concrete nor shall there be any deviation from alignment in excess of 3 mm.

353.07.09 Cold Weather Concreting

Protection of concrete shall be according to OPSS 904. The components of the curb and gutter system shall be considered as slabs on the ground.

353.07.10 Catch Basin and Maintenance Hole Frames and Grates

Catch basin and maintenance hole frames and grates which lie within the flow lines of the curb and gutter system shall be installed as part of the construction of the various components making up the curb and gutter system. Frames shall be set to their final elevation according to OPSS 407. The exposed surfaces of the mortar bed shall be left in a smooth condition, free of depressions, and projections. All remaining formwork shall be removed.

353.07.11 Identification Stamp

At the request of the Contract Administrator, each end of the work and every 20 m shall be legibly marked with an approved stamp. The mark shall be located in the centre of an exposed face of the curb and gutter systems. The mark shall bear the Contractor's name and the year of construction.

353.07.12 Field Sampling and Testing of Concrete

Field sampling and testing of concrete shall be according to OPSS 1350.

Field sampling and testing of concrete shall be according to OPSS 1350.PROV.

353.07.13 Management of Excess Material

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

353.09 MEASUREMENT FOR PAYMENT

353.09.01 Actual Measurement

353.09.01.01 Concrete Curb and Gutter

Measurement of concrete curb and gutter shall be by length in metres along the flow line of the gutter whether straight or curved, without separation into types. Such measurements shall include the space occupied by setbacks, gutter outlets, and frames with grates.

353.09.01.02 Concrete Spillways

Measurement of concrete spillways shall be by length in metres along the flow line from the end of the gutter outlet to the spillway termination.

353.09.01.03 Concrete Gutter Outlets

For measurement purposes, a count shall be made of the number of setbacks and gutter outlets installed without separation into types.

353.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clause under Actual Measurement.

353.10 BASIS OF PAYMENT

353.10.01 Concrete Curb and Gutter - Item Concrete Spillways - Item Concrete Gutter Outlets - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

When roadbed granular material is measured in square metres, the Contract price for the above item shall be full compensation for all labour, Equipment, and Material for the material directly below or behind the concrete curb and gutter system.

There shall be no separate payment of concrete used for fillets in bullnoses.

353.10.02 Hot Mix Asphalt

Hot mix asphalt designated for constructing bullnose fillets shall be paid for at the Contract price for the appropriate Hot Mix Asphalt tender item.

353.10.03 Granular

Granular materials required for the work shall be paid for at the Contract price for the appropriate granular tender item.

353.10.04 Excavation

Excavation required to set the various components to the required line and grade shall be considered as part of the work of installing the curb and gutter system. When such excavation overlaps excavation required for any other work under the Contract, then payment shall be made in accordance with the specification for such other work as though no excavation were required for curb and gutter construction.

353.10.05 Steel Reinforcement

Costs for supplying and placing steel reinforcement are deemed to be included in the items for concrete curb and gutter systems.

Appendix 353-A, Commentary for OPSS.MUNI 353, November 2016 FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

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

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Line and grade for curb and gutter systems. (353.07.05)
- Testing frequency. (353.07.12)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 600.010	Concrete Barrier Curb with Wide Gutter
OPSD 600.020	Concrete Semi-Mountable Curb with Wide Gutter
OPSD 600.030	Concrete Mountable Curb with Wide Gutter
OPSD 600.040	Concrete Barrier Curb with Standard Gutter
OPSD 600.060	Concrete Semi-Mountable Curb with Standard Gutter
OPSD 600.070	Concrete Barrier Curb with Standard Gutter, Two-Stage Construction
OPSD 600.080	Concrete Barrier Curb with Narrow Gutter
OPSD 600.090	Concrete Semi-Mountable Curb with Narrow Gutter
OPSD 600.100	Concrete Mountable Curb with Narrow Gutter
OPSD 600.110	Concrete Barrier Curb
OPSD 604.010	90° Concrete Outlet for Concrete Curb with Gutter
OPSD 605.010	45° Concrete Outlet for Concrete Curb with Gutter
OPSD 605.030	45° Concrete Outlet for Concrete Curb with Gutter at End of Run
OPSD 606.010	600 mm Radius Barrier Bullnose
OPSD 606.020	600 mm Radius Mountable Bullnose
OPSD 606.030	800 mm Radius Mountable Bullnose, Curb with Gutter Twin Inlet
OPSD 607.010	Over 600 mm Radius Mountable Bullnose
OPSD 607.020	Over 600 mm Radius Barrier Bullnose
OPSD 608.010	Method of Termination for Concrete Curb with Gutter



CONSTRUCTION SPECIFICATION FOR THE INSTALLATION OF INTERLOCKING CONCRETE PAVERS

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APPENDICES

335-A	Commentary

355.01 SCOPE

This specification covers the requirements for the installation of interlocking concrete pavers for pavements, sidewalks, boulevards, and medians. The work includes the grading, placement of subsurface drainage, subbase, base, bedding sand, joint sand, edge restraints, and interlocking concrete pavers. This specification applies to both manual and mechanical installations.

355.01.01 Specification Significance and Use

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

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 206	Grading
OPSS 310	Hot Mix Asphalt
OPSS 314	Untreated Granular, Subbase, Base, Surface Shoulder, and Stockpiling
OPSS 350	Concrete Pavement and Concrete Base
OPSS 405	Pipe Subdrains
OPSS 501	Compacting

Ontario Provincial Standard Specifications, Material

OPSS 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 according to OPSS 1002. For applications under vehicular traffic, manufactured sand shall be used. Limestone screenings or stone dust shall not be used.

Joint sand shall be dry and meet the gradation requirements of mortar sand according to OPSS 1004 and the physical requirements according to OPSS 1002.

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 75 kN per square metre of plate area. The frequency of vibration shall be within the range of 75 to 100Hz.

Pneumatic-tired roller shall have a gross weight of 10 tonnes.

355.07 CONSTRUCTION

355.07.01 Subgrade Preparation

Preparation of the subgrade shall be according to OPSS 206.

355.07.02 Subbase and Base

When the interlocking concrete pavers are being placed on:

- a) Granular base, the base and subbase layers shall be constructed according to OPSS 314.
- b) Concrete base, the base layer shall be constructed according to OPSS 350.
- c) Asphalt base, the base layer shall be constructed according to OPSS 310.

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 not be greater than 3 mm for vehicular applications and not greater than 6 mm for other applications.

355.07.10 Removal of Unacceptable Concrete Pavers

All loose concrete pavers and concrete pavers that do not meet the surface tolerance shall be removed and reinstalled.

All damaged concrete pavers shall be removed and replaced.

355.07.11 Management of Excess Material

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

355.09 MEASUREMENT FOR PAYMENT

355.09.01 Actual Measurement

355.09.01.01 Interlocking Concrete Pavers

Measurement shall be made for the area of concrete pavers placed in square metres without deduction for maintenance hole covers, Utility poles, and other appurtenances.

355.09.02 Plan Quantity Payment

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clause under Actual Measurement.

355.10 BASIS OF PAYMENT

355.10.01 Interlocking Concrete Pavers-Item

Payment at the Contract price for the above item shall be full compensation for all labour, Equipment, and Material to do the work.

Removal and reinstallation of loose concrete pavers or concrete pavers not meeting surface tolerances shall be at no extra cost to the Owner.

Removal and replacement of damaged concrete pavers shall be at no additional cost to the Owner.

**Appendix 355-A, November 2014
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS**

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

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Size, shape, colour, thickness, and texture of the concrete pavers. (355.05.04)
- Type of edge restraint. (355.05.05)
- Type and depth of subbase and base required for traffic loads and soil conditions. (355.07.02)
- Subsurface drainage requirements and adequate drainage of the bedding sand at low points. (355.07.03)
- Pattern of concrete pavers. (355.07.06)

Application should be restricted to roads with traffic speeds of 70 km/h or less.

A herringbone pattern at 45° to the vehicular traffic is recommended for roadway pavements.

Where surface sealers are specified, a reduction in frictional resistance may result.

Related technical publications for designers' use are available from the Interlocking Concrete Pavement Institute (ICPI) at www.icpi.org.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 561.010	Interlocking Concrete Pavers on Granular Base
OPSD 561.020	Interlocking Concrete Pavers on Concrete or Asphalt Base
OPSD 561.030	Interlocking Concrete Pavers for Retrofit Crosswalk Installation



CONSTRUCTION SPECIFICATION FOR REPAIRING RIGID PAVEMENT WITH PRECAST CONCRETE SLABS

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363-A	Commentary

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

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

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 350	Concrete Pavement and Concrete Base
OPSS 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 1441	Load Transfer Assemblies
OPSS 1442	Epoxy Coated Steel Reinforcement for Concrete

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

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, the Contractor shall provide to the Contract Administrator details on the method of:

- 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 Contractor shall be responsible for the precast concrete mix design and shall submit the concrete mix design to the Contract Administrator according to OPSS 1350.

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, the Contractor shall submit a concrete mix design for flowable fill to the Contract Administrator according to OPSS 1350. 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 Contractor shall submit to the Contract Administrator the name of the PCRM selected for use and the manufacturer's specifications and recommendations for placement. 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 by the Contractor shall be acceptable to the Owner.

363.04.01.05 Chipping Hammer

At least one week prior to commencement of the work, the Contractor shall submit to the Contract Administrator a copy of the manufacturer's published specifications on the chipping hammers to be used.

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 Tie Bars and Dowel Bars

Tie bars shall be according to OPSS 1442. Dowel bars shall be according to OPSS 1441.

363.05.01.05 Dimensions

Precast concrete slabs shall be full-lane width and length of 2 to 4.5 m. Prior to fabrication, the Contractor shall determine the concrete thickness at each repair location. 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 1442. 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

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 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 3 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 the Contractor may elect to use 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 bars slots, placing of flowable fill levelling material, placing precast slabs, installing PCRM in dowel bar slots, and sealing of joints.

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.

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, the Contractor shall demonstrate 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. The Contractor shall provide a proposal for repairs 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.

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 shall not be 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, the Contractor shall immediately take corrective action.

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 Proprietary Concrete Repair Material in Dowel Bar Slots

All concrete surfaces within the slot shall be according to the 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. The Contractor shall assure that each batch of PCRM is consistent.

When placing the PCRM in the slot, the Contractor shall not spill any onto the adjacent concrete surface. 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 to moving on to the next slab.

If slabs are to be opened to traffic prior to they are grouted, incompressible shims shall be placed at approximate $\frac{1}{4}$ 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 Installing the PCRM - 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 PCRM 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 in previously-filled ports shall be continually monitored and grout added, as required, to keep the grout level in the ports even with the top of the slab. This shall maintain a safe and adequate head pressure on the bedding grout until all voids under the slab are filled. Prior to 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

The Contractor shall cast, cure, handle, and deliver concrete test cylinders 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. The Contractor shall cast, cure, handle, and deliver two sets of two standard 150 x 300 mm cylinders to represent a day's placement. 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

The Contractor shall be responsible for sampling the PCRM from the mixer in the field and making cubes for determination of the early strength and 28-Day compressive strength. The PCRM cubes shall be moulded 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 by the Contractor. The Contractor shall make one set of six cubes 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 Contractor is responsible for the timing of testing and frequency of testing of the early strength cubes and shall determine 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 Contractor shall demould and transport the specimens 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

The Contractor shall carry out Falling Weight Deflectometer (FWD) testing 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, the Contractor shall provide access 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, the Contractor shall provide access 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.

The Contract Administrator shall reject precast concrete pavement slab repairs 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.

The Contractor shall submit a detailed remedial plan 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

The designer should specify the following in the Contract Documents:

- Time period allowed to complete each repair location. (363.07.02)
- Location of QA laboratory. (363.07.09.03)

Precast concrete slab repairs are typically used in areas where overnight or short duration repairs are required.

For information on the Fort Miller Super-Slab[®] Method, contact:

The Fort Miller Co. Inc.
P.O. Box 98
Schuylerville, NY, USA 12871
Phone: (518) 695-5000

For information on the Michigan Method, contact:

Research Engineer, Forensic Studies
Testing and Research Section, Pavement Unit
Michigan Department of Transportation
Secondary Complex, 8885 Ricks Road
P.O. Box 30049
Lansing, MI, USA 48909
Phone: (517) 322-5732

The designer should provide pavement and base thickness and condition information based on pre-engineering investigations.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.



**CONSTRUCTION SPECIFICATION FOR
CROSS-STITCHING LONGITUDINAL CRACKS IN
CONCRETE PAVEMENT AND CONCRETE BASE**

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365-A	Commentary

365.01	SCOPE

This specification covers the requirements for cross-stitching longitudinal cracks in concrete pavement and concrete base.

365.01.01 Specification Significance and Use

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

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

365.01.02 Appendices Significance and Use

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 369 Sealing or Resealing of Joints and Cracks in Concrete Pavement and Concrete Base

Ontario Provincial Standard Specifications, Material

OPSS 1440 Steel Reinforcement for Concrete
OPSS 1442 Epoxy Coated Reinforcing Steel Bars for Concrete

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 Owner's pre-qualified product list.

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

For measurement purposes, a count shall be made of the number of tie bars installed.

365.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

365.10 BASIS OF PAYMENT

365.10.01 Cross-Stitching - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

Drill holes not within the specified tolerances shall be filled with epoxy and abandoned at no additional cost to the Owner.

365.10.02 Sealing of Longitudinal Cracks

Payment for the sealing of longitudinal cracks shall be according to OPSS 369.

Appendix 365-A, November 2014
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

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

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Tie bar size and length requirements. (365.05.01)
- Tie bar installation requirements. (365.07.01)
- Tender item for sealing the longitudinal cracks. (365.07.02 and 365.10.02)

Cross-stitching is a method used to tie together longitudinal cracks in concrete pavement and concrete base. Cross-stitching can be applied to longitudinal cracks that are in reasonably good condition. The purpose of cross-stitching is to maintain aggregate interlock, provide added reinforcement to cracks, and prevent horizontal and vertical movement of the concrete crack and slab migration. As this process is not suitable for transverse cracks, consideration should be given to specifying dowel bar retrofits.

Pre-design investigation should determine the thickness of the concrete slab over the length of the pavement. The thickness of the concrete should be specified in the Contract Documents.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 560.025 Concrete Pavement and Concrete Base, Cross-Stitching Longitudinal Cracks



CONSTRUCTION SPECIFICATION FOR 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 municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

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

401.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

401.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 206	Grading
OPSS 403	Rock Excavation for Pipelines, Utilities, and Associated Structures in Open Cut
OPSS 404	Support Systems
OPSS 412	Sewage Forcemain Installation in Open Cut
OPSS 441	Watermain Installation in Open Cut
OPSS 490	Site Preparation for Pipelines, Utilities, and Associated Structures
OPSS 491	Preservation, Protection, and Reconstruction of Existing Facilities
OPSS 492	Site Restoration Following Installation of Pipelines, Utilities, and Associated Structures
OPSS 501	Compacting
OPSS 510	Removal
OPSS 517	Dewatering 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 Work Area.

Native Material means the material removed to form an excavation within the Work 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 the definition as provided in the *Occupational Health and Safety Act* and Regulations for Construction Projects.

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.

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, watermain 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 paid for as Extra 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 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

The designer may consider including soil boring data, a geotechnical report, a subsurface report, or a soils report in the tender documents.

The designer may consider specifying requirements for a pre-condition survey in the Contract Documents.

The designer should specify the following in the Contract Documents:

- Type of embedment material. (401.05.01)
- Type of bedding material. (401.05.02)
- Type of cover material. (401.05.03)
- Type of backfill material. (401.05.05.01)
- Trench line, grade, and dimensions. (401.07.09)
- Pipe bedding class and dimensions. (401.07.10.03)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 802.010	Flexible Pipe Embedment and Backfill, Earth Excavation
OPSD 802.013	Flexible Pipe Embedment and Backfill, Rock Excavation
OPSD 802.014	Flexible Pipe Embedment in Embankment, Original Ground: Earth or Rock
OPSD 802.020	Flexible Pipe Arch Embedment and Backfill, Earth Excavation
OPSD 802.023	Flexible Pipe Arch Embedment and Backfill, Rock Excavation
OPSD 802.024	Flexible Pipe Arch Embedment in Embankment, Original Ground: Earth or Rock
OPSD 802.030	Rigid Pipe Bedding, Cover and Backfill, Type 1 or 2 Soil - Earth Excavation
OPSD 802.031	Rigid Pipe Bedding, Cover and Backfill, Type 3 Soil - Earth Excavation
OPSD 802.032	Rigid Pipe Bedding, Cover and Backfill, Type 4 Soil - Earth Excavation
OPSD 802.033	Rigid Pipe Bedding, Cover and Backfill, Rock Excavation
OPSD 802.034	Rigid Pipe Bedding and Cover in Embankment, Original Ground: Earth or Rock
OPSD 802.050	Horizontal Elliptical Rigid Pipe Bedding, Cover and Backfill, Type 1 or 2 Soil - Earth Excavation
OPSD 802.051	Horizontal Elliptical Rigid Pipe Bedding, Cover and Backfill, Type 3 Soil - Earth Excavation
OPSD 802.052	Horizontal Elliptical Rigid Pipe Bedding, Cover and Backfill, Type 4 Soil - Earth Excavation
OPSD 802.053	Horizontal Elliptical Rigid Pipe Bedding, Cover and Backfill, Rock Excavation
OPSD 802.054	Horizontal Elliptical Rigid Pipe Bedding and Cover in Embankment, Original Ground: Earth or Rock
OPSD 803.010	Backfill and Cover for Concrete Culverts
OPSD 803.030	Frost Treatment - Pipe Culverts, Frost Penetration Line Below Bedding Grade
OPSD 803.031	Frost Treatment - Pipe Culverts, Frost Penetration Line Between Top of Pipe and Bedding Grade



**CONSTRUCTION SPECIFICATION FOR
EXCAVATING, BACKFILLING, AND COMPACTING
FOR MAINTENANCE HOLES, CATCH BASINS,
DITCH INLETS, AND VALVE CHAMBERS**

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402.04	DESIGN AND SUBMISSION REQUIREMENTS - Not Used
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402.08	QUALITY ASSURANCE - Not Used
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APPENDICES

402-A	Commentary

402.01 SCOPE

This specification covers the requirements for excavating, backfilling, and compacting for the installation of storm and sanitary pipe sewer maintenance holes, storm sewer catch basins and ditch inlets, and valve chambers for watermains and forcemains.

402.01.01 Specification Significance and Use

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

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

402.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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.

402.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 206	Grading
OPSS 403	Rock Excavation for Pipelines, Utilities, and Associated Structures in Open Cut
OPSS 404	Support Systems
OPSS 490	Site Preparation for Pipelines, Utilities, and Associated Structures
OPSS 491	Preservation, Protection, and Reconstruction of Existing Facilities
OPSS 492	Site Restoration Following Installation of Pipelines, Utilities, and Associated Structures
OPSS 501	Compacting
OPSS 510	Removal
OPSS 517	Dewatering of Pipeline, Utility, and Associated Structure Excavation

Ontario Provincial Standard Specifications, Material

OPSS 1010	Aggregates - Base, Subbase, Select Subgrade, and Backfill Material
OPSS 1359	Unshrinkable Backfill

402.03

DEFINITIONS

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

Additional Excavation means all excavation ordered in writing by the Contract Administrator beyond excavation specified in the Contract Documents.

Backfilling means the operation of filling the excavation with bedding and backfill material.

Backfill Material means approved fill material used above the bedding and below the lower of the subgrade or finished grade or original ground.

Bedding Material means the material used to support the maintenance hole, catch basin, ditch inlet, or valve chamber.

Excavation, Earth and Rock means the excavation classified as earth and rock according to OPSS 206.

Imported Material means material obtained from a source other than the Work Area.

Native Material means the material removed to form an excavation within the Work Area for return to the same or other excavation.

Over-Excavation means all excavation beyond that specified in the Contract Documents, performed without the written order of the Contract Administrator.

Structure means maintenance hole, catch basin, ditch inlet, or valve chamber.

Unshrinkable Fill means a controlled density cement treated aggregate material.

402.05

MATERIALS

402.05.01

Granular Material

Granular material shall be according to OPSS 1010.

402.05.02

Backfill Material

402.05.02.01

General

Backfill material shall be as specified in the Contract Documents.

402.05.02.02

Native and Imported Material

Native and imported material shall be material approved by the Contract Administrator. All material shall be free from frozen lumps, cinders, ashes, refuse, vegetable or organic matter, rocks, and boulders over 25 mm in any dimension, and other deleterious material.

402.05.03

Unshrinkable Fill

Unshrinkable fill shall be according to OPSS 1359.

402.07 CONSTRUCTION

402.07.01 General

Excavations shall be stable and dry, unless designated as subaqueous Work.

402.07.02 Site Preparation

Site preparation shall be according to OPSS 490.

402.07.03 Preservation and Protection of Existing Facilities

Preservation and protection of existing facilities shall be according to OPSS 491.

402.07.04 Removals

Removals shall be according to OPSS 510.

402.07.05 Dewatering

Dewatering shall be according to OPSS 517.

402.07.06 Support Systems

Support systems shall be according to OPSS 404.

402.07.07 Removal of Frozen Ground

Written permission shall be obtained from the Contract Administrator prior to starting an excavation in frozen ground. The method used for removal of frozen ground shall not cause damage to adjacent structures, roadways, or Utilities.

402.07.08 Excavation

402.07.08.01 General

Excavation shall be performed to the lines, elevations, and dimensions specified in the Contract Documents plus an allowance for support systems, where required.

Rock excavation for maintenance holes, catch basins, ditch inlets, or valve chambers shall be according to OPSS 403.

402.07.08.02 Additional Excavation

Structures shall not be placed or constructed on an unsuitable foundation as may be determined by the Contract Administrator.

Unsuitable material shall be excavated and the resulting excavation shall be backfilled and compacted to obtain a suitable foundation.

402.07.08.03 Over-Excavation

Corrective measures ordered by the Contract Administrator to rectify deficiencies caused by over-excavation shall be performed. Soil that has become disturbed by construction methods or procedures shall be removed and replaced with granular material compacted to 95% maximum dry density where the excavated surface is below or beside the proposed structure.

402.07.09 Backfilling and Compacting

402.07.09.01 Bedding

A 150 mm layer of granular bedding material shall be placed on the bottom of the excavation and compacted according to OPSS 501, prior to the placing of a structure.

402.07.09.02 Backfill

Backfill material shall be placed simultaneously on all sides of the structure in layers not exceeding 300 mm in thickness, loose measurement, and compacted according to OPSS 501, prior to the placement of a subsequent layer.

Backfill material shall not commence around cast-in-place concrete structures until approval has been obtained from the Contract Administrator.

402.07.10 Additional Excavating, Backfilling, and Compacting

Additional excavating, backfilling, and compacting shall be as described in the Excavation and Backfilling and Compacting subsections.

The volume of the excavation that is in addition to the limits specified in the Contract Documents shall be determined.

402.07.11 Site Restoration

Site restoration shall be according to OPSS 492.

402.07.12 Management of Excess Material

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

402.09 MEASUREMENT FOR PAYMENT

402.09.01 Actual Measurement

402.09.01.01 Additional Excavating, Backfilling, and Compacting

Additional excavating, backfilling, and compacting shall be based on the volume of the additional excavation measured in cubic metres prior to installation of a structure.

The volume of the additional excavation shall be determined beyond the limits specified in the Contract Documents.

402.10 BASIS OF PAYMENT

402.10.01 Excavating, Backfilling, and Compacting for Maintenance Holes, Catch Basins, Ditch Inlets, and Valve Chambers

Payment at the Contract price for the appropriate tender items for the installation of maintenance holes, catch basins, ditch inlets, and valve chambers shall be full compensation for all labour, Equipment, and Material to do the work.

When the Contract contains separate items for work required by this specification, payment shall be at the Contract prices and according to the specifications for such work.

Any expenses for remedial work resulting from over-excavation shall be borne by the Contractor.

402.10.02 Additional Excavating, Backfilling, and Compacting - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

402.10.03 Rock Excavation for Maintenance Holes, Catch Basins, Ditch Inlets, and Valve Chambers

Payment for rock excavation for maintenance holes, catch basins, ditch inlets, and valve chambers shall be according to OPSS 403.

Appendix 402-A, Commentary for OPSS.MUNI 402, November 2016 FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

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

Designer Action/Considerations

The designer may consider including soil boring data, a geotechnical report, a subsurface report, or a soils report in the tender documents.

The designer should specify the following in the Contract Documents:

- Type of backfill material. (402.05.02)
- Lines, elevations, and dimensions of structure excavation. (402.07.08.01)
- Investigate and resolve any overlapping work. (402.07.10.01)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 701.010 to 701.015	Precast Concrete Maintenance Holes, 1,200 mm to 3,600 mm in Diameter
OPSD 701.030 to 701.081	Precast Concrete Maintenance Hole Components, 1,200 mm to 3,600 mm in Diameter
OPSD 702.040 to 702.050	Precast Concrete Ditch Inlet Maintenance Hole, 1,200 mm x 1,200 mm
OPSD 703.011 to 703.015	Precast Concrete Single Inlet Flat Cap, 1,500 mm to 3,600 mm in Diameter
OPSD 703.021 to 703.024	Precast Concrete Twin Inlet Flat Cap, 1,500 mm to 3,000 mm in Diameter
OPSD 705.010 to 705.020	Precast Concrete Catch Basins
OPSD 705.030 to 705.040	Precast Concrete Ditch Inlets
OPSD 706.010 to 706.041	Precast Concrete Ditch Inlets with 1,500 mm to 3,000 mm Diameter Flat Cap
OPSD 1100.010	Cast-In-Place Chamber for Valves up to 350 mm Diameter
OPSD 1101.010	Precast Valve Chamber, 1,200 mm and 1,500 mm Diameter
OPSD 1101.012 to 1101.015	Precast Concrete Valve Chamber with Poured-In-Place Thrust Blocks, 1,800 mm x 2,400 mm
OPSD 1101.016 to 1101.019	Precast Concrete Valve Chamber with Poured-In-Place Thrust Blocks, 2,400 mm x 3,000 mm



**CONSTRUCTION SPECIFICATION FOR ROCK EXCAVATION FOR PIPELINES,
UTILITIES, AND ASSOCIATED STRUCTURES IN OPEN CUT**

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403.08	QUALITY ASSURANCE - Not Used
403.09	MEASUREMENT FOR PAYMENT
403.10	BASIS OF PAYMENT

APPENDICES

403-A	Commentary

403.01 SCOPE

This specification covers the rock excavation requirements for the installation of sanitary and storm pipe sewers, pipe culverts and end sections, forcemains and associated appurtenances, and watermain and associated appurtenances; underground Utilities; and maintenance holes, catch basins, ditch inlets, and valve chambers in open cut.

403.01.01 Specification Significance and Use

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

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

403.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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.

403.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 206	Grading
OPSS 412	Sewage Forcemain Installation in Open Cut
OPSS 441	Watermain Installation in Open Cut

403.03 DEFINITIONS

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

Associated Appurtenances means as defined in OPSS 412 and OPSS 441.

Associated Structures means a maintenance hole, catch basin, ditch inlet, or valve chamber.

Rock means rock as defined in OPSS 206.

403.07 CONSTRUCTION

403.07.01 General

Rock excavation to install sanitary and storm pipe sewers, pipe culverts and end sections, forcemains and associated appurtenances, and watermain and associated appurtenances; underground Utilities; and maintenance holes, catch basins, ditch inlets, and valve chambers in open cut shall be performed to the lines and grades specified in the Contract Documents.

403.07.02 Use of Explosives

The requirements for the use of explosives shall be as specified in the Contract Documents.

403.07.03 Management of Excess Material

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

403.09 MEASUREMENT FOR PAYMENT

403.09.01 Actual Measurement

403.09.01.01 Rock Excavation for Pipelines, Utilities and Associated Structures

Measurement shall be in cubic metres.

The volume of rock excavation for pipelines, Utilities, and associated structures shall be determined by the product of the relevant following dimensions measured in place:

a) Height

The height of rock excavation for pipelines, Utilities, and associated structures is the difference in elevation between the theoretical bottom of bedding and the lower of the top of the original rock or the top of shatter.

The top of the original rock shall be determined using one of the following methods:

- i. Elevations taken after the overburden has been removed but before rock excavation.
- ii. From rock surface elevations on both sides of the excavation after rock excavation has been completed.

b) Width

The width of rock excavation for pipelines and Utilities is the actual width of trench measured horizontally to a maximum of the specified trench width.

c) Length

The length of rock excavation for pipelines and Utilities is measured horizontally along the centreline of the trench to the outside limits of the backfill for the associated structures or to the outlet end of a pipe where it emerges from the rock.

d) Horizontal

The horizontal measurement for associated structures is the:

- i. diameter at the external surfaces of a circular structure plus 300 mm all around; or
- ii. the length and width to the external surfaces of a rectangular or square structure plus 300 mm on all sides.

Where the excavation for this item overlaps rock excavation for other items there shall be no deduction for the overlap.

The volume of boulders in an excavation shall be determined by the product of the three maximum rectilinear dimensions. Where boulders classified as rock are measured for payment, only the amount actually removed shall be considered for payment, the total volume of rock considered for payment shall not exceed the volume of excavation within the theoretical lines.

403.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

403.10 BASIS OF PAYMENT

403.10.01 Rock Excavation for Trenches and Associated Structures - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

**Appendix 403-A, Commentary for OPSS.MUNI 403, November 2016
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS**

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

Designer Action/Considerations

The designer may consider including soil boring data, a geotechnical report, a subsurface report, or a soils report in the tender documents.

The designer should specify the following in the Contract Documents:

- Line and grade requirements of sanitary and storm pipe sewers, pipe culverts and end sections, forcemains and associated appurtenances, and watermains and associated appurtenances; underground Utilities; and maintenance holes, catch basins, ditch inlets, and valve chambers. (403.07.01)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR PIPE SEWER INSTALLATION IN OPEN CUT

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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 of storm and sanitary pipe sewers, laterals, service connections, and concrete appurtenances in open cut.

410.01.01 Specification Significance and Use

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

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

410.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

410.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 206	Grading
OPSS 401	Trenching, Backfilling, and Compacting
OPSS 404	Support Systems
OPSS 407	Maintenance Hole, Catch Basin, Ditch Inlet, and Valve Chamber Installation
OPSS 409	Closed-Circuit Television Inspection of Pipelines
OPSS 490	Site Preparation for Pipelines, Utilities, and Associated Structures
OPSS 491	Preservation, Protection, and Reconstruction of Existing Facilities
OPSS 492	Site Restoration Following Installation of Pipelines, Utilities, and Associated Structures
OPSS 510	Removal
OPSS 517	Dewatering of Pipeline, Utility, and Associated Structure Excavation
OPSS 539	Temporary Protection Systems
OPSS 904	Concrete Structures
OPSS 905	Steel Reinforcement for Concrete

Ontario Provincial Standard Specifications, Material

OPSS 1004	Aggregates - Miscellaneous
OPSS 1205	Clay Seal
OPSS 1301	Cementing Materials
OPSS 1302	Water
OPSS 1350	Concrete - Materials and Production
OPSS 1440	Steel Reinforcement for Concrete
OPSS 1801	Corrugated Steel Pipe Products
OPSS 1820	Circular Concrete Pipe
OPSS 1840	Non-Pressure Polyethylene Plastic Pipe Products
OPSS 1841	Non-Pressure Polyvinyl Chloride (PVC) Pipe Products

OPSS 1843 Non-Pressure Polypropylene (PP) Plastic Pipe Products
OPSS 1860 Geotextiles

CSA Standards

B182.1-11 Plastic Drain and Sewer Pipe and Pipe Fittings
[Part of B1800-11, Plastic Non-Pressure Pipe Compendium]

ASTM International

C 507-12 Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe

410.03 DEFINITIONS

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

Backfilling means the operation of filling the trench with bedding, cover, and backfill material or embedment and backfill material.

Concrete Appurtenances means concrete head walls, cut-off walls, stiffeners, aprons, collars, and any other concrete fixtures associated with the pipe sewer, excluding concrete bedding or concrete structures specified in the Contract Documents.

Dimension Ratio means the average specified outside diameter of a pipe divided by the minimum specified wall thickness.

Drainage Structure means a maintenance hole, catch basin, or ditch inlet.

Excavation, Earth and Rock means the excavation classified as earth and rock according to OPSS 206.

Flexible Pipe means pipe that can deflect 2% or more without cracking, such as polyvinyl chloride or polyethylene or steel pipe.

Pipe Class means a pipe's physical material specification, such as load and pressure ratings, wall thickness, protective coatings, corrugation profiles, ring stiffness constants, and reinforcement.

Pipe Run means a section of a pipe sewer between two drainage structures or between a drainage structure and an outlet.

Pipe Sewer means an installation designed for the conveyance of sanitary sewage or storm water using preformed or precast pipe sections, circular or non-circular in cross-section, laid end to end using suitable jointing material and connected by maintenance holes for sanitary pipe sewers and by maintenance holes, catch basins, ditch inlets, or concrete appurtenances for storm pipe sewers.

Pipe Type means a pipe's inner wall design, which can be smooth or corrugated.

Polypropylene Plastic means a material made with virgin polymers in which propylene is essentially the sole monomer.

Service Connection means the pipe used to convey sanitary sewage or storm water from the property line to the main sanitary or storm pipe sewer respectively.

410.05 MATERIALS

410.05.01 Pipe Materials

410.05.01.01 General

Pipe sewer size, type, and class shall be as specified in the Contract Documents.

Pipe sewer size and class shall be consistent throughout a pipe run as specified in the Contract Documents. Pipe type shall be consistent throughout a pipe sewer as specified in the Contract Documents.

Fittings shall be suitable for and compatible with the pipe type and class for which they will be used.

410.05.01.02 Concrete Pipe

Circular concrete pipe and joints shall be according to OPSS 1820.

Elliptical concrete pipe and joints shall be according to ASTM C 507.

410.05.01.03 Corrugated Steel Pipe Products

Corrugated steel pipe products shall be according to OPSS 1801.

410.05.01.04 Polyethylene Pipe Products

Polyethylene pipe products shall be according to OPSS 1840.

410.05.01.05 Polyvinyl Chloride Pipe Products

Polyvinyl chloride pipe products shall be according to OPSS 1841.

Polyvinyl chloride service connection pipe shall be according to CSA B182.1 and shall have bell and spigot joints with elastomeric gaskets.

410.05.01.06 Polypropylene Plastic Pipe Products

Polypropylene plastic pipe products shall be according to OPSS 1843.

410.05.02 Mortar

Mortar for joints shall be composed of one part 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

410.07.12.06 Polyvinyl Chloride Pipe

Polyvinyl chloride pipe shall be jointed, as recommended by the manufacturer, using a bell and spigot joint with an elastomeric gasket.

At the end of a day's work, the last pipe shall be blocked as may be required to prevent movement.

410.07.12.07 Polypropylene Pipe

Polypropylene pipe shall be jointed by means of a bell and spigot joint with elastomeric gasket or a coupler joint as recommended by the manufacturer to satisfy the pipe joint specification.

410.07.13 Service Connections

Service connections to the main pipe sewer shall be made using factory made tees or wyes, strap-on-saddles, or other approved saddles. Factory made tees or wyes shall be used for all service connections when the diameter of the main pipe sewer is:

- a) less than 450 mm; or
- b) less than twice the diameter of the service connection.

Strap-on-saddles shall be installed before laying the pipe.

Holes in the main pipe sewer shall be cut with approved cutters and shall be the minimum diameter required to accept the service connection saddle. If mortar-on saddles are used, the inside of the pipe shall be mortared at the connection.

Service connections shall be plugged at the property line with watertight caps or plugs. Plugs or caps shall be braced sufficiently to withstand test pressures.

When existing service connections shall be connected to new pipe sewers or service connections, proper jointing procedures shall be used.

410.07.14 Marking and Recording Service Connections

A painted temporary location marker consisting of a 50 x 75 mm stake or two short sections of lumber connected by a piece of heavy gauge wire shall be placed at the end of the plugged or capped service connection. The marker shall be placed from 300 mm below the finished grade to a point 300 mm above the plugged end of the service pipe.

A painted surface stake, 50 x 75 x 450 mm long, shall be placed after trench restoration.

Service connections shall not be backfilled until they have been inspected and measurements of location have been taken by the Contract Administrator.

410.07.15 Breaking into Maintenance Holes, Catch Basins, Ditch Inlets, Pipe Culverts, and Pipe Sewers

Openings shall be made as necessary in an existing maintenance hole, catch basin, ditch inlet, pipe culvert, or pipe sewer to install the new pipe sewer and connect it to the structure according to OPSS 407. Benching in existing maintenance holes shall be altered to accommodate the flow in the new pipe sewer system.

When specified in the Contract Documents, the opening for the connection of a subdrain outlet shall be formed by coring. The subdrain outlet pipe shall be sealed into place using non-shrink grout. When specified in the Contract Documents, a 50 mm diameter weep hole shall be cored into the same wall as the subdrain connection and at the same invert elevation.

410.07.16 Field Testing

410.07.16.01 General

Field tests described in this subsection shall be conducted when specified in the Contract Documents and applied to sanitary and storm pipe sewers. All tests shall be carried out in the presence of and accepted by the Contract Administrator.

When specified in the Contract Documents, leakage tests shall be carried out on completed pipe sewers 1,200 mm in diameter and smaller. There shall be no visible leakage for pipe sewers larger than 1,200 mm diameter.

Testing shall be carried out from maintenance hole to maintenance hole, including house service connections as work progresses.

The construction of new mainline pipe sewers shall not proceed when three previously placed sections of the pipe sewer have not been tested or have been tested and are unsatisfactory.

Leakage up to 25% in excess of the calculated limits shall be approved in any test section provided that the excess is offset by lower leakage measurements in adjacent sections so that the total leakage is within the allowable limits for the combined sections.

Pipe sewers shall be repaired and retested, as required, until the test results are within the limits specified in this specification. Visible leaks shall be repaired regardless of the test results.

No part of the work shall be accepted until the pipe sewers are satisfactorily tested following completion of installation of service connections and backfilling.

410.07.16.02 Prequalification Leakage Tests

Prequalification leakage tests shall be carried out as either infiltration or exfiltration tests, as required.

The test shall be performed on the first section of the pipe sewer of each size, not less than 100 m in length, installed by each crew in order to prequalify the crew and the material. Tests may be carried out prior to service connections being installed in the section being tested.

When tests are unsatisfactory, the test section shall be repaired and retested until satisfactory results are obtained.

410.07.16.03 Infiltration Test

Dewatering operations shall be discontinued at least three days prior to conducting the test and allow for the groundwater level to stabilize. Infiltration tests shall be conducted when the groundwater level at the time of testing is 600 mm or more above the crown of the pipe for the entire length of the test section. The test section is normally between adjacent maintenance holes.

A watertight bulkhead shall be constructed at the upstream end of the test section. All service laterals, stubs, and fittings shall be plugged or capped to prevent water entering at these locations. A V-notch weir or other suitable measuring device shall be installed at the downstream end of the test section. Infiltrating water shall be allowed to build up behind the weir until the flow through the V-notch has stabilized. The rate of flow shall then be measured. The rate of flow shall not exceed the maximum allowable infiltration calculated for the test section. Allowable infiltration shall be calculated as 0.075 litres/millimetre diameter/100 metres of pipe sewer/hour.

410.07.16.04 Exfiltration Test

410.07.16.04.01 General

Exfiltration tests shall be conducted when the groundwater level is lower than 600 mm above the crown of the pipe or the highest point of the highest service connection included in the test section.

The test section is normally between adjacent maintenance holes. The test section of the pipe sewer shall be isolated by temporarily plugging the downstream end and all incoming pipes of the upstream maintenance hole. All service laterals, stubs, and fittings are plugged or capped to prevent water entering at these locations.

410.07.16.04.02 Testing With Water

The test section shall be slowly filled with water ensuring that all air is removed from the line. A period of 24 hours for absorption or expansion shall be allowed prior to starting the test, except if exfiltration requirements are met by a test carried out during the absorption period.

Water shall be added to the pipeline prior to testing until there is a head in the upstream maintenance hole of 600 mm minimum over the crown of the pipe or at least 600 mm above the existing groundwater level, whichever is greater. The maximum limit of the net internal head on the line is 8 m. In calculating the net internal head, allowance for groundwater head, if any, shall be made.

The distance from the maintenance hole frame to the surface of the water shall be measured. After allowing the water to stand for one hour, the distance from the frame to the surface of the water shall again be measured. The leakage shall be calculated using volumes.

The leakage at the end of the test period shall not exceed the maximum allowable calculated for the test section. Allowable leakage shall be calculated as 0.075 litres/millimetre diameter/100 metres of pipe sewer/hour.

An allowance of 3.0 litres per hour per metre of head above the invert for each maintenance hole included in the test section shall be made.

Maintenance holes shall be tested separately, if the test section fails.

410.07.16.04.03 Low Pressure Air Testing

The Contract Administrator may allow or require testing by use of air when water is not readily available or the differential head in the test section is greater than 8 m or freezing temperatures exist.

Air control equipment that includes a shut off valve, safety valve, pressure regulating valve, pressure reduction valve and monitoring pressure gauge with pressure range from 0 to 35 kPa with minimum divisions of 0.5 kPa and accuracy of approximately 0.25 kPa shall be provided.

Tests shall be conducted between two consecutive maintenance holes. The test section shall be plugged at each end. One plug shall be equipped with an air inlet connection to fill the pipe sewer system with air.

The test section shall be filled slowly until a constant pressure of 24 kPa is maintained. If the groundwater is above the pipe sewer being tested, the air pressure shall be increased by 3.0 kPa for each 300 mm that the groundwater level is above the invert of the pipe.

The air pressure shall be stabilized for five minutes and then regulated to maintain it to 20.5 kPa plus the allowance for groundwater, if any. After the stabilization period, the time taken for a pressure loss of 3.5 kPa shall be recorded.

The time taken for a pressure drop of 3.5 kPa shall not be less than the times shown in Table 1.

If the length of the test section is greater than the length for minimum time, the new testing time shall be a product of the length of test section multiplied by the time shown in Table 1 for the appropriate size pipe.

If the results of an air test are marginal, the Contract Administrator may require the section to be retested using water.

410.07.16.05 Deflection Testing of Pipe Sewers

Ring deflection testing shall be performed on all pipe sewers constructed using flexible pipe. The allowable deflected pipe diameter is calculated as:

Pipes 100 to 750 mm:	7.5% of the Base Inside Diameter of the Pipe
Pipes Greater Than 750 mm:	5.0% of the Base Inside Diameter of the Pipe

Where:

Base Inside Diameter is defined in the CSA or ASTM standard to which the pipe is manufactured.

A suitably designed device as defined below shall be pulled through the pipe sewer to demonstrate that the pipe deflection does not exceed the allowable deflected pipe diameter. The device shall be pulled manually through the pipe not sooner than 30 Days after the completion of backfilling and installation of service connections.

The suitably designed device shall be a mandrel, cylindrical in shape, and constructed with an odd number of evenly spaced arms or prongs, minimum 9 in number. The minimum diameter of the circle scribed around the outside of the mandrel arms shall be equal to the allowable deflected pipe diameter ± 1 mm. The contact length of the mandrel shall be measured between the points of contact on the mandrel arm or between sets of prongs. This length shall not be less than that shown in Table 2.

The mandrel shall be checked with a go-no-go proving ring. The proving ring shall have a diameter equal to the allowable deflected pipe diameter ± 0.1 mm. An acceptable mandrel shall not pass through the proving ring. The proving ring shall be fabricated from steel a minimum of 6 mm thick.

Any section of pipe that does not allow the mandrel to pass shall be considered to have failed the deflection test.

All sections of pipe that fail the deflection test shall be repaired and retested.

410.07.16.06 Closed-Circuit Television (CCTV) Inspection

Pipe sewers shall be inspected using CCTV equipment. CCTV inspection of pipe sewers shall be according to OPSS 409.

410.07.17 Cleaning and Flushing of Pipe Sewers

When specified in the Contract Documents, all pipe sewers shall be cleaned and flushed immediately prior to inspection and acceptance.

410.07.18 Clay Seals

Clay seals shall be placed as specified in the Contract Documents and compacted to 95% of the maximum dry density.

410.07.19 Concrete Appurtenances

Concrete appurtenances shall be constructed as specified in the Contract Documents. Concrete in concrete appurtenances shall be placed according to OPSS 904. Steel reinforcement shall be placed according to OPSS 905. Steel grating shall be installed when specified in the Contract Documents.

410.07.20 Site Restoration

Site restoration shall be according to OPSS 492.

410.07.21 Management of Excess Material

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

410.09 MEASUREMENT FOR PAYMENT

410.09.01 Actual Measurement

410.09.01.01 Pipe Sewers

Measurement of pipe sewers shall be by length in metres along the horizontal centreline length of the pipe from the centre of one drainage structure to the centre of another drainage structure or outlet end of the pipe sewer. When the grade of the pipe sewer is 10% or greater, the above measurement is then of the slope length.

410.09.01.02 Service Connections

Measurement of the service connections shall be by length in metres along its horizontal centreline from the centreline of the main pipe sewer to the end of the service connection.

410.09.01.03 Breaking into Maintenance Holes, Catch Basins, Ditch Inlets, Pipe Culverts, and Pipe Sewers

For measurement purposes, a count shall be made of the number of openings made in maintenance holes, catch basins, ditch inlets, pipe culverts and pipe sewers.

410.09.01.04 Concrete Appurtenances

Measurement for concrete appurtenances shall be by volume in cubic metres for the volume of concrete placed. Alternatively, concrete appurtenances may be a lump sum item.

410.09.01.05 Clay Seal

Measurement for clay seal shall be by volume in cubic metres for the volume of clay placed. Alternatively, clay seal may be a lump sum item.

410.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

410.10**BASIS OF PAYMENT****410.10.01*****"size, type, class"* Pipe Sewers - Item****Service Connections - Item****Breaking into Maintenance Holes, Catch Basins, Ditch Inlets, Culverts and Sewers - Item****Concrete Appurtenances - Item****Clay Seal - Item**

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

410.10.02**Closed-Circuit Television (CCTV) Inspection**

When a CCTV inspection of pipe sewers is specified in the Contract Documents, payment for CCTV inspection shall be according to OPSS 409.

TABLE 1
Exfiltration Test - Low Pressure Air Testing

NominalPipe Size mm	MinimumTime min:sec	Length for Minimum Time m	Time For Longer Length sec
100	1:53	182	0.623
150	2:50	121	1.140
200	3:47	91	2.493
250	4:43	73	3.893
300	5:40	61	5.606
375	7:05	48	8.761
450	8:30	41	12.615
525	9:55	35	17.171
600	11:20	30	22.425
675	12:45	27	28.382
750	14:10	24	35.040
825	15:35	22	42.397
900	17:00	20	50.450

TABLE 2
Deflection Testing of Pipe Sewers

Nominal Pipe Size mm	Mandrel Contact Length mm
150	100
200	150
250	200
300	250
350	300
375	300
400	300
450	350
500	400
525	450
600	500
675	575
750	675
900	750
1050	900
1200	1050

Appendix 410-A, November 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

The designer should specify the following in the Contract Documents:

- Pipe sewer size, type, and class. (410.05.01.01)
- Pipe size. (410.05.01.01)
- Size and grade of steel reinforcement. (410.05.05)
- Alignment and grade tolerances for the pipe installation. (410.07.12.01)
- Placement of clay seals. (410.07.18)
- Requirements to construct concrete appurtenances. (410.07.19)
- Depth of backfill over the pipe sewer. (410.07.20)

The designer should determine if the following are required and, if so, add the requirement in the Contract Documents:

- Use of nitrile gaskets. (410.07.12.01)
- Use of joint seals with corrugated steel pipe products. (410.07.12.04)
- Coring for the installation of subdrain. (410.07.15)
- Coring of a 50 mm diameter weep hole. (410.07.15)
- Field tests. (410.07.16.01)
- Cleaning and flushing prior to inspection and acceptance. (410.07.17)
- Use of steel grating. (410.07.19)
- Payment of concrete appurtenances by volume or lump sum. (410.09.01.04)

The tender item description for pipe sewer should include reference to one or more of the attributes shown, i.e., *size, type, class*. (410.10.01)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Appendix 410-A

Related Ontario Provincial Standard Drawings

OPSD 708.010	Catch Basin Connection for Rigid Main Pipe Sewer
OPSD 708.020	Support for Pipe at Catch Basin or Maintenance Hole
OPSD 708.030	Catch Basin Connection for Flexible Main Pipe Sewer
OPSD 802.010	Flexible Pipe Embedment and Backfill Earth Excavation
OPSD 802.013	Flexible Pipe Embedment and Backfill Rock Excavation
OPSD 802.014	Flexible Pipe Embedment in Embankment Original Ground: Earth or Rock
OPSD 802.020	Flexible Pipe Arch Embedment and Backfill Earth Excavation
OPSD 802.023	Flexible Pipe Arch Embedment and Backfill Rock Excavation
OPSD 802.024	Flexible Pipe Arch Embedment in Embankment Original Ground: Earth or Rock
OPSD 802.030	Rigid Pipe Bedding, Cover, and Backfill, Type 1 or 2 Soil - Earth Excavation
OPSD 802.031	Rigid Pipe Bedding, Cover, and Backfill, Type 3 Soil - Earth Excavation
OPSD 802.032	Rigid Pipe Bedding, Cover, and Backfill, Type 4 Soil - Earth Excavation
OPSD 802.033	Rigid Pipe Bedding, Cover, and Backfill, Rock Excavation
OPSD 802.034	Rigid Pipe Bedding and Cover in Embankment, Original Ground: Earth or Rock
OPSD 802.050	Horizontal Elliptical Rigid Pipe Bedding, Cover, and Backfill, Type 1 or 2 Soil - Earth Excavation
OPSD 802.051	Horizontal Elliptical Rigid Pipe Bedding, Cover, and Backfill, Type 3 Soil - Earth Excavation
OPSD 802.052	Horizontal Elliptical Rigid Pipe Bedding, Cover, and Backfill, Type 4 Soil - Earth Excavation
OPSD 802.053	Horizontal Elliptical Rigid Pipe Bedding, Cover, and Backfill, Rock Excavation
OPSD 802.054	Horizontal Elliptical Rigid Pipe Bedding and Cover in Embankment, Original Ground: Earth or Rock
OPSD 802.095	Clay Seal for Pipe Trenches
OPSD 804.030	Concrete Headwall for Pipe Less Than 900 mm Diameter
OPSD 804.040	Concrete Headwall for Sewer or Culvert Pipe
OPSD 804.050	Grating for Concrete Endwall
OPSD 805.010	Height of Fill Table, Round Corrugated Steel Pipe and Structural Plate Corrugated Steel Pipe
OPSD 805.020	Height of Fill Table, Corrugated Steel Pipe Arch and Structural Plate Corrugated Steel Pipe Arch
OPSD 805.030	Height of Fill Table, Spiral Rib Round Pipe
OPSD 805.040	Height of Fill Table, Spiral Rib Pipe Arch
OPSD 806.020	Height of Fill Table, Dual Wall Corrugated Polyethylene Gravity Sewer Pipe, 210 and 320 kPa
OPSD 806.021	Height of Fill Table, Closed Profile Wall Polyethylene Pipe, RSC 160 and 250
OPSD 806.022	Height of Fill Table, Dual Wall Corrugated Polyethylene Gravity Sewer Pipe, RSC 100 and RSC 160
OPSD 806.030	Height of Fill Table, Dual and Triple Wall Corrugated Polypropylene Gravity Sewer Pipe, 320 kPa
OPSD 806.040	Height of Fill Table, Polyvinyl Chloride Gravity Sewer Pipe, 210, 320, and 625 kPa
OPSD 806.060	Height of Fill Table, Polyvinyl Chloride Pressure Pipe for Different Dimension Ratios
OPSD 807.010	Height of Fill Table, Reinforced Concrete Pipe - Confined Trench Class 50-D, 65-D, 100-D, and 140-D
OPSD 807.030	Height of Fill Table, Reinforced Concrete Pipe - Embankment Class 50-D, 65-D, 100-D, and 140-D
OPSD 807.040	Height of Fill Table - Nonreinforced Concrete Pipe Class 3
OPSD 807.050	Height of Fill Table, Horizontal Elliptical Concrete Pipe Class HE-A, HE-I, HE-II, HE-III, and HE-IV
OPSD 1006.010	Sewer Service Connections for Rigid Main Pipe Sewer
OPSD 1006.020	Sewer Service Connections for Flexible Main Pipe Sewer



CONSTRUCTION SPECIFICATION FOR PIPE CULVERT INSTALLATION IN OPEN CUT

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421.01 SCOPE

This specification covers the requirements for the installation of pipe culverts, pipe culvert end sections, and concrete appurtenances in open cut.

421.01.01 Specification Significance and Use

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

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

421.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

421.02 REFERENCES

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

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

Ontario Provincial Standards Specifications, Construction

OPSS 206	Grading
OPSS 401	Trenching, Backfilling, and Compacting
OPSS 404	Support Systems
OPSS 409	Closed-Circuit Television (CCTV) Inspection of Pipelines
OPSS 490	Site Preparation for Pipelines, Utilities, and Associated Structures
OPSS 491	Preservation, Protection, and Reconstruction of Existing Facilities
OPSS 492	Site Restoration Following Installation of Pipelines, Utilities, and Associated Structures
OPSS 510	Removal
OPSS 517	Dewatering of Pipeline, Utility, and Associated Structure Excavation
OPSS 539	Temporary Protection Systems
OPSS 904	Concrete Structures
OPSS 905	Steel Reinforcement for Concrete

Ontario Provincial Standard Specifications, Material

OPSS 1004	Aggregates - Miscellaneous
OPSS 1205	Clay Seal
OPSS 1301	Cementing Materials
OPSS 1302	Water
OPSS 1350	Concrete - Materials and Production
OPSS 1440	Steel Reinforcement for Concrete
OPSS 1801	Corrugated Steel Pipe Products
OPSS 1820	Circular Concrete Pipe

OPSS 1840	Non-Pressure Polyethylene Plastic Pipe Products
OPSS 1841	Non-Pressure Polyvinyl Chloride (PVC) Pipe Products
OPSS 1843	Non-Pressure Polypropylene (PP) Plastic Pipe Products
OPSS 1860	Geotextiles

ASTM International

C 507-12 Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe

421.03 DEFINITIONS

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

Backfilling means the operation of filling the trench with bedding, cover, and backfill material or embedment and backfill material.

Concrete Appurtenances means concrete head walls, cut-off walls, stiffeners, aprons, collars, and any other concrete fixtures associated with the pipe culvert, excluding concrete bedding or concrete structures specified in the Contract Documents.

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.

Pipe Class means a pipe's physical material specification, such as load and pressure ratings, wall thickness, protective coatings, corrugation profiles, ring stiffness constants, and reinforcement.

Pipe Culvert means an installation designed to provide for the conveyance of surface water, pedestrians, or livestock using preformed or precast pipe sections, circular or non-circular in cross-section, laid end to end using suitable joint materials.

Pipe Type means a pipe's inner wall design, which can be smooth or corrugated.

Polypropylene Plastic means a material made with virgin polymers in which propylene is essentially the sole monomer.

421.05 MATERIALS

421.05.01 Pipe Materials

421.05.01.01 General

Pipe culvert size, type, and class shall be as specified in the Contract Documents.

Pipe culvert type shall be consistent throughout the length of the pipe culvert as specified in the Contract Documents.

Fittings shall be suitable for and compatible with the pipe type and class for which they will be used.

421.05.01.02 Concrete Pipe

Circular concrete pipe and joints shall be according to OPSS 1820.

Elliptical concrete pipe and joints shall be according to ASTM C 507.

421.05.01.03 Corrugated Steel Pipe Products

Corrugated steel pipe products shall be according to OPSS 1801.

421.05.01.04 Polyethylene Pipe Products

Polyethylene pipe products shall be according to OPSS 1840.

421.05.01.05 Polyvinyl Chloride Pipe Products

Polyvinyl chloride pipe products shall be according to OPSS 1841.

421.05.01.06 Polypropylene Plastic Pipe Products

Polypropylene plastic pipe products shall be according to OPSS 1843.

421.05.02 Mortar

Mortar for joints shall consist of one part Portland cement and two parts mortar sand, wetted with sufficient water to only make the mixture plastic. The mortar sand shall be according to OPSS 1004, the normal Portland cement shall be according to OPSS 1301, and the water shall be according to OPSS 1302.

421.05.03 Clay Seal

Clay seal material shall be according to OPSS 1205.

421.05.04 Concrete

Concrete for concrete appurtenances shall be according to OPSS 1350 with a nominal minimum 28-Day compressive strength of 30 MPa.

421.05.05 Steel Reinforcement

Steel reinforcement shall be of the size and grade specified in the Contract Documents and shall be according to OPSS 1440.

421.05.06 Geotextile

Geotextile shall be according to OPSS 1860.

421.07 CONSTRUCTION

421.07.01 Site Preparation

Site preparation shall be according to OPSS 490.

421.07.02 Removals

Removals shall be according to OPSS 510.

421.07.03 Preservation and Protection of Existing Facilities

Preservation and protection of existing facilities shall be according to OPSS 491.

421.07.04 Protection Against Floatation

Damage to the pipeline due to floatation shall be prevented during construction and until completion of the work.

421.07.05 Cold Weather Work

All work shall be protected from freezing. Pipes and bedding material shall not be placed on frozen ground.

421.07.06 Transporting, Unloading, Storing, and Handling Pipe

Manufacturer's recommendations for transporting, unloading, storing, and handling of pipe, shall be followed.

All pipes, fittings, and gaskets that are unsound or damaged shall be rejected.

421.07.07 Excavation

Excavation for the placement of pipe culverts shall be according to OPSS 401.

421.07.08 Support Systems

Support systems shall be according to OPSS 404.

421.07.09 Dewatering

Dewatering shall be according to OPSS 517.

421.07.10 Protection Systems

The construction of all protection systems shall be according to OPSS 539. When the stability, safety or function of an existing roadway, railway, other works, or proposed works may be impaired due to the method of operation, such protection as may be required shall be provided. Protection may include sheathing, shoring and driving piles, when necessary, to prevent damage to such works or proposed works.

421.07.11 Backfilling and Compacting

Backfilling and compacting shall be according to OPSS 401.

421.07.12 Pipe Installation

421.07.12.01 General

If a universal dimple coupler or any other coupler does not follow the contour of the flexible pipe sections to be joined, polyethylene gaskets shall then be installed at all joints when such couplers are used. Polyethylene gaskets shall be installed symmetrically about the pipe joint, between the coupler and the pipe, and shall be of sufficient length to equal the circumference of the pipe plus a minimum overlap of 300 mm.

Pipe shall be laid within the alignment and grade tolerances specified in the Contract Documents. When bell and spigot pipe is laid, the bell end of the pipe shall be laid upgrade.

Pipe shall be kept clean and dry as work progresses. The trench shall be kept dry. A removable watertight bulkhead shall be installed at the open end of the last pipe laid whenever work is suspended.

Pipe shall not be laid until the preceding pipe joint has been completed and the pipe is carefully embedded and secured in place.

When the Owner raises or lowers the invert of a pipe culvert by up to 150 mm, it shall not constitute a Change in the Work and no adjustment shall be made to the payment. When the invert of a pipe culvert is raised or lowered by more than 150 mm, then this shall constitute a Change in the Work for the full extent of the change from the original grade.

The pipe culvert cut-end finish, end sections, and safety slope end treatments shall be as specified in the Contract Documents.

When installing gaskets, all pipe ends shall be thoroughly cleaned. For gaskets requiring field lubrication, a lubricant recommended by the pipe manufacturer shall be used.

When gaskets have been affixed, the pipe shall be handled in a way so that the gasket is not damaged, displaced, or contaminated with foreign matter. Any gasket displaced or contaminated shall be removed, cleaned, and lubricated, if required, and reinstalled before closure of the joint is attempted. When specified in the Contract Documents, nitrile gaskets shall be used.

The pipe shall be properly positioned by means of an appropriate mechanism. Sufficient pressure shall be applied in making the joint to ensure that the joint is in position. Sufficient restraint shall be applied to the line to ensure that joints are held in this position.

Once the pipe has been jointed, a test shall be made with a feeler gauge at intervals around the joint to ensure that the gasket has not been displaced from the spigot groove. If the gasket is found out of position, the joint shall be opened and the gasket placed in its proper position. If necessary, a new gasket shall be installed.

421.07.12.02 Circular Concrete Pipe

All circular concrete pipe joints shall have elastomeric gaskets.

421.07.12.03 Non-Circular Concrete Pipe

All non-circular concrete pipe joints shall be according to the procedures recommended by the manufacturer.

421.07.12.04 Corrugated Steel Pipe Products

Helical corrugated steel pipe without rerolled ends shall be installed so that the helix angle is constant for the total length of the installation. Each pipe section shall be installed next to the previous section so that the lockseam forms a continuous helix. For rerolled ends, the correct fit of the coupling system does not depend on the location of the helical lockseam and corrugation.

Corrugated steel pipe sections shall be joined by means of steel couplers. The couplers shall be installed to lap approximately equal portions of the pipe being connected so that the corrugations or projections of the coupler properly engage the pipe corrugations. As the coupler is being tightened, it shall be tapped with a mallet to take up the slack.

When joint seals are specified in the Contract Documents, they shall be installed immediately prior to the installation of steel couplers.

Structural plate pipe culverts may be assembled in the trench or beside the excavation. If the assembled structure has to be moved to its final position, it shall be moved so that no damage or distortion is caused to the structure.

When the structural plate pipe culvert has been placed to the alignment and grade as specified in the Contract Documents, all assembly bolts shall be retightened with a torque wrench to a minimum of:

- a) 200 N·m for 3.5 and 3.0 mm gauge of pipe.
- b) 340 N·m for heavier than 3.5 mm gauge of pipe.

421.07.12.05 Polyethylene Pipe

Polyethylene pipe shall be jointed by one of the following methods, as recommended by the pipe manufacturer:

- a) Bell and Spigot
- b) Welded Joint
- c) Thermal Fusion Joint
- d) Screw-on Coupler
- e) Split Coupler
- f) Threaded Joint

421.07.12.06 Polyvinyl Chloride Pipe

Polyvinyl chloride pipe shall be jointed, as recommended by the manufacturer, using a bell and spigot joint with an elastomeric gasket.

At the end of a day's work, the last pipe shall be blocked as may be required to prevent movement.

421.07.12.07 Polypropylene Pipe

Polypropylene pipe shall be jointed by means of a bell and spigot joint with elastomeric gasket or a coupler joint as recommended by the manufacturer to satisfy the pipe joint specification.

421.07.13 Closed-Circuit Television (CCTV) Inspection

When specified in the Contract Documents, pipe culverts shall be inspected using CCTV equipment. CCTV inspection of pipe culverts shall be according to OPSS 409.

421.07.14 Cleaning and Flushing of Pipe Culverts

When specified in the Contract Documents, pipe culverts shall be cleaned and flushed just prior to inspection and acceptance.

421.07.15 Clay 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.

421.09 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.

421.10.02 Swamp Excavation

When the Contract requires swamp excavation to place a pipe culvert, payment for the swamp excavation shall be under the tender item covering the swamp excavation for earth embankment construction. No alterations shall be made to the tender item for the pipe culvert so affected.

421.10.03 Closed-Circuit Television (CCTV) Inspection

When a CCTV inspection of pipe culverts is specified in the Contract Documents, payment for the CCTV inspection shall be according to OPSS 409.

Appendix 421-A, November 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

The designer should specify the following in the Contract Documents:

- Pipe culvert size, type, and class. (421.05.01.01)
- Size and grade of steel reinforcement. (421.05.05)
- Alignment and grade tolerances, including camber, for the pipe installation. (421.07.12.01)
- Pipe culvert cut-end finish, end sections, and safety slope end treatments. (421.07.12.01)
- Alignment and grade for the placement of structural plate pipe culvert. (421.07.12.04)
- Placement of clay seals at the inlet side of culverts, as required. (421.07.15)
- Requirements to construct concrete appurtenances. (421.07.16)
- Pipe culvert size, type, class, or other pipe attribute to complete the tender item description. (421.10.01)

The designer should determine if the following are required and, if so, add the requirement in the Contract Documents:

- Use of nitrile gaskets. (421.07.12.01)
- Use of joint seals with corrugated steel pipe products. (421.07.12.04)
- CCTV inspection and any other testing. (421.07.13)
- Cleaning and flushing prior to inspection and acceptance. (421.07.14)
- Use of steel grating. (421.07.16)
- Payment of concrete appurtenances by volume or lump sum. (421.09.01.02)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 800.010	Concrete Pipe Culvert and Sewer Extensions Using Corrugated Steel Pipe
OPSD 800.011	Concrete Rigid Frame Box and Open Culvert Extensions Using Corrugated Steel Pipe
OPSD 801.010	Cut End Finish, Circular Pipe and Pipe-Arch Corrugated Steel Pipe
OPSD 801.020	End Section Details, Corrugated Steel Pipe
OPSD 801.030	Bevel Details for Structural Plate Pipe and Pipe-Arch - Corrugated Steel Pipe

Appendix 421-A

OPSD 801.040	Culvert and Sewer Safety Slope End Treatment, Notes and Tables
OPSD 801.041	Culvert and Sewer Safety Slope End Treatment, Assembly Details
OPSD 801.042	Culvert and Sewer Safety Slope End Treatment, Connection Details
OPSD 801.043	Culvert and Sewer Safety Slope End Treatment, Installation Details
OPSD 802.010	Flexible Pipe Embedment and Backfill, Earth Excavation
OPSD 802.013	Flexible Pipe Embedment and Backfill, Rock Excavation
OPSD 802.014	Flexible Pipe Embedment in Embankment, Original Ground: Earth or Rock
OPSD 802.020	Flexible Pipe Arch Embedment and Backfill, Earth Excavation
OPSD 802.023	Flexible Pipe Arch Embedment and Backfill, Rock Excavation
OPSD 802.024	Flexible Pipe Arch Embedment in Embankment, Original Ground: Earth or Rock
OPSD 802.030	Rigid Pipe Bedding, Cover, and Backfill, Type 1 or 2 Soil - Earth Excavation
OPSD 802.031	Rigid Pipe Bedding, Cover, and Backfill, Type 3 Soil - Earth Excavation
OPSD 802.032	Rigid Pipe Bedding, Cover, and Backfill, Type 4 Soil - Earth Excavation
OPSD 802.033	Rigid Pipe Bedding, Cover, and Backfill, Rock Excavation
OPSD 802.034	Rigid Pipe Bedding and Cover in Embankment, Original Ground: Earth or Rock
OPSD 802.050	Horizontal Elliptical Rigid Pipe Bedding, Cover, and Backfill, Type 1 or 2 Soil - Earth Excavation
OPSD 802.051	Horizontal Elliptical Rigid Pipe Bedding, Cover, and Backfill, Type 3 Soil - Earth Excavation
OPSD 802.052	Horizontal Elliptical Rigid Pipe Bedding, Cover, and Backfill, Type 4 Soil - Earth Excavation
OPSD 802.053	Horizontal Elliptical Rigid Pipe Bedding, Cover, and Backfill, Rock Excavation
OPSD 802.054	Horizontal Elliptical Rigid Pipe Bedding and Cover in Embankment, Original Ground: Earth or Rock
OPSD 802.095	Clay Seal for Pipe Trenches
OPSD 804.030	Concrete Headwall, for Pipe Less Than 900 mm Diameter
OPSD 804.040	Concrete Headwall, for Sewer or Culvert Pipe Outlet
OPSD 804.050	Grating, for Concrete Endwall
OPSD 805.010	Height of Fill Table, Round Corrugated Steel Pipe and Structural Plate Corrugated Steel Pipe
OPSD 805.020	Height of Fill Table, Corrugated Steel Pipe Arch and Structural Plate Corrugated Steel Pipe Arch
OPSD 805.030	Height of Fill Table, Spiral Rib Round Pipe
OPSD 805.040	Height of Fill Table, Spiral Rib Pipe Arch
OPSD 806.020	Height of Fill Table, Dual Wall Corrugated Polyethylene Gravity Sewer Pipe, 210 and 320 kPa
OPSD 806.021	Height of Fill Table, Closed Profile Wall Polyethylene Pipe, RSC 160 and 250
OPSD 806.022	Height of Fill Table, Dual Wall Corrugated Polyethylene Gravity Sewer Pipe RSC 100 and RSC 160
OPSD 806.030	Height of Fill Table, Dual and Triple Wall Corrugated Polypropylene Gravity Sewer Pipe, 320 kPa
OPSD 806.040	Height of Fill Table, Polyvinyl Chloride Gravity Sewer Pipe, 210, 320, and 625 kPa
OPSD 806.060	Height of Fill Table, Polyvinyl Chloride Pressure Pipe for Different Dimension Ratios
OPSD 807.010	Height of Fill Table, Reinforced Concrete Pipe - Confined Trench, Class 50-D, 65-D, 100-D, and 140-D
OPSD 807.030	Height of Fill Table, Reinforced Concrete Pipe - Embankment, Class 50-D, 65-D, 100-D, and 140-D
OPSD 807.040	Height of Fill Table, Non-reinforced Concrete Pipe Class 3
OPSD 807.050	Height of Fill Table, Horizontal Elliptical Concrete Pipe, Class HE-A, HE-I, HE-II, HE-III, and HE-IV



CONSTRUCTION SPECIFICATION FOR WATERMAIN INSTALLATION IN OPEN CUT

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441.01 SCOPE

This specification covers the requirements for the installation of watermains, service connections, and associated appurtenances in open cut.

441.01.01 Specification Significance and Use

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

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

441.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

441.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 206	Grading
OPSS 401	Trenching, Backfilling, and Compacting
OPSS 404	Support Systems
OPSS 442	Corrosion Protection of New and Existing Watermains
OPSS 490	Site Preparation for Pipeline, Utilities, and Associated Structures
OPSS 491	Preservation, Protection, and Reconstruction of Existing Facilities
OPSS 492	Site Restoration Following Installation of Pipelines, Utilities, and Associated Structures
OPSS 493	Temporary Potable Water Supply Services
OPSS 510	Removal
OPSS 517	Dewatering of Pipeline, Utility, and Associated Structure Excavation
OPSS 539	Temporary Protection Systems

Ontario Provincial Standard Specifications, Material

OPSS 1004	Aggregates - Miscellaneous
OPSS 1301	Cementing Materials
OPSS 1302	Water
OPSS 1350	Concrete - Materials and Production
OPSS 1842	Pressure Polyethylene Pipe Products

CSA Standards

B64.5-11	Double Check Valve (DCVA) Backflow Preventers

B137.1-13	[Part of B64 Series-11, Backflow Preventers and Vacuum Breakers Compendium] Polyethylene Pipe, Tubing and Fittings for Cold-Water Pressure Services
B137.2-13	[Part of B137-13, Thermoplastic Pressure Piping Compendium] Polyvinyl Chloride (PVC) Injection-Moulded Gasketed Fittings for Pressure Applications
B137.3-13	[Part of B137-13, Thermoplastic Pressure Piping Compendium] Rigid Polyvinyl Chloride (PVC) Pipe and Fittings for Pressure Applications
B137.3.1-13	[Part of B137-13, Thermoplastic Pressure Piping Compendium] Molecularly Oriented Polyvinyl Chloride (PVCO) Pipe and Fittings for Pressure Applications
B137.10-13	[Part of B137-13, Thermoplastic Pressure Piping Compendium] Crosslinked Polyethylene/Aluminum/Crosslinked Polyethylene Composite Pressure-Pipe Systems [Part of B137-13, Thermoplastic Pressure Piping Compendium]

ASTM International

A 153M-09	Zinc Coating (Hot Dip) on Iron and Steel Hardware
A 276-15	Stainless Steel Bars and Shapes
A 307-14	Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength
B 88-09	Seamless Copper Water Tube
B 633-13	Electrodeposited Coatings of Zinc on Iron and Steel
B 766-86 (2015)	Electrodeposited Coatings of Cadmium
C 361-14a	Reinforced Concrete Low-Head Pressure Pipe
D 3139-98 (2011)	Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals

American Water Works Association (AWWA)

C104/A21.4-08	Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
C110/A21.10-12	Ductile-Iron and Gray-Iron Fittings for Water
C111/A21.11-12	Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
C151/A21.51-02	Ductile-Iron Pipe, Centrifugally Cast, for Water
C153/A21.53-11	Ductile-Iron Compact Fittings for Water Service
C200-15	Steel Water Pipe - 6 In. (150 mm) and Larger
C205-12	Cement-Mortar Protective Lining and Coating for Steel Water Pipe - 4 in. (100 mm) and Larger
C206-11	Field Welding of Steel Water Pipe
C208-12	Dimensions for Fabricated Steel Water Pipe Fittings
C301-14	Prestressed Concrete Pressure Pipe, Steel-Cylinder Type, for Water and Other Liquids
C302-11	Reinforced Concrete Pressure Pipe, Non-Cylinder Type
C303-08	Concrete Pressure Pipe, Bar-Wrapped, Steel-Cylinder Type
C502-14	Dry-Barrel Fire Hydrants
C504-15	Rubber-Seated Butterfly Valves
C509-15	Resilient-Seated Gate Valves for Water Supply Service
C510-07	Double Check Valve Backflow Prevention Assembly
C800-14	Underground Service Line Valves and Fittings
C900-07	Polyvinyl Chloride (PVC) Pressure Pipe, and Fabricated Fittings, 4 in.-12 in. (100 mm - 300 mm), for Water Transmission and Distribution
C905-10	Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 350 mm Through 1,200 mm (14 in. Through 48 in.) for Water Transmission and Distribution
C907-12	Injection-Molded Polyvinyl Chloride (PVC) Pressure Fittings, 4 in.-12 in. (100 mm - 300 mm), for Water Distribution
C909-09	Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe, 100 mm Through 600 mm (4 in. Through 24 in.), for Water Distribution

American Society of Mechanical Engineers (ASME)

B18.2.1-2010 Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series)

NSF International

61-2008 Drinking Water System Components - Health Effects

Ministry of Environment and Climate Change (MOECC)

Watermain Disinfection Procedure

441.03 DEFINITIONS

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

Associated Appurtenance means structures, devices, and appliances, other than pipe and conduit, which are used in connection with a water distribution system, such as valves, hydrants, corporation cocks, services, and thrust restraints.

Backfilling means the operation of filling a trench with bedding, cover, and backfill material, or embedment and backfill material.

End Covers means temporary cover installed at the factory over both ends of uninstalled watermain pipe to prevent the entry of contaminants during shipping and storage.

Excavation, Earth and Rock means the excavation classified as earth and rock according to OPSS 206.

Fitting means connections, appliances, and adjuncts designed to be used in connection with pipe: for example, elbows and bends to alter the direction of a pipe; tees and crosses to connect a branch with a main; plugs and caps to close an end; and bushings, diminishers, or reducers to couple two pipes of different diameters.

Service Connection means the system used to supply water from the watermain to the property line.

Service Connection Appurtenance Set means the main stop, curb stop, couplings, service box, service box support, and service saddle used in the installation of a service connection.

Watermain means an installation designed for the conveyance of water under pressure.

441.05 MATERIALS

441.05.01 General

The pipe size shall be according to the size specified in the Contract Documents. Pipe type and class shall be as specified in the Contract Documents.

Fittings shall be suitable for and compatible with the pipe material and class with which they are used.

All material for watermains and Associated Appurtenances shall be NSF/ANSI 61 compliant.

441.05.02 Ductile Iron Pipe

Ductile iron pipe shall be according to AWWA C151/A21.51.

Fittings shall be gray iron according to AWWA C110/A21.10 or ductile iron according to AWWA C110/A21.10 or AWWA C153.

Ductile iron pipe and fittings shall be cement lined according to AWWA C104/A21.4.

Rubber gaskets for push-on or mechanical joints shall be according to AWWA C111/A21.11.

441.05.03 Concrete Pressure Pipe

Concrete cylinder pipe including joints and fittings shall be according to AWWA C301 or AWWA C303.

Non-cylinder pipe and joints shall be according to AWWA C302 or ASTM C 361. Fittings shall be according to AWWA C302.

441.05.04 Polyvinyl Chloride Pipe

441.05.04.01 General

Flexible elastomeric seals for bell and spigot joints shall be according to ASTM D 3139.

Fittings for polyvinyl chloride (PVC) and molecularly oriented polyvinyl chloride (PVCO) pipe shall be either:

- a) Gray iron according to AWWA C110/A21.10.
- b) Ductile iron according to C110/A21.10 or AWWA C153 and shall be cement lined according to AWWA C104/A21.4.
- c) Injection moulded polyvinyl chloride, blue in colour and according to AWWA C907 and CSA B137.2.
- d) Prefabricated polyvinyl chloride, blue in colour and according to AWWA C905 and CSA B137.3.

441.05.04.02 Polyvinyl Chloride Pipe (PVC)

Polyvinyl chloride pipe shall be according to AWWA C900 or AWWA C905 and CSA B137.3, and shall be blue in colour and supplied complete with gaskets.

441.05.04.03 Molecularly Oriented Polyvinyl Chloride Pipe (PVCO)

Molecularly oriented polyvinyl chloride pipe shall be according to AWWA C909 and CSA B137.3.1, and shall be blue in colour and supplied complete with gaskets.

441.05.05 Polyethylene Pipe

Polyethylene pressure pipe shall be according to OPSS 1842.

Fittings shall be either:

- a) Flanged gray iron according to AWWA C110/A21.10.
- b) Flanged ductile iron according to AWWA C110/A21.10 or AWWA C153 and shall be cement lined according to AWWA C104/A21.4.

- c) Polyethylene according to OPSS 1842.
- d) Heat fusion or insert or compression type fittings according to CSA 137.1.

441.05.06 Steel Pipe

Steel pipe shall be according to AWWA C200. Fittings shall be according to AWWA C208. Steel pipe shall have a cement-mortar protective lining and coating according to AWWA C205.

441.05.07 Copper Pipe

Copper pipe for service connections shall be according to ASTM B 88 and shall be type K soft copper.

441.05.08 Composite Pipe

Crosslink polyethylene/aluminum/crosslink polyethylene composite pressure pipe for service connections shall be according to CSA B137.10.

441.05.09 Valves

441.05.09.01 General

All valves shall open by operating in a counter clockwise direction.

Valves shall be designed for a minimum cold water working pressure of 1,035 kPa.

Valve types shall be one of the following:

- a) Valves less than 75 mm shall be brass or bronze gate valves.
- b) Valves greater than or equal to 75 mm, and less than or equal to 300 mm, shall be cast or ductile iron gate valves.
- c) Valves greater than 300 mm up to and including 500 mm shall be gate or butterfly valves.
- d) Valves greater than 500 mm shall be butterfly valves.

Fasteners shall be made from material meeting the strength requirements of ASTM A 307 with dimensions according to ASME B18.2.1. Bolts, studs, and nuts shall be cadmium plated according to ASTM B 766 or zinc coated according to ASTM A 153 or ASTM B 633. Fasteners for mechanical joints shall be ductile iron according to AWWA C111/A21.11.

441.05.09.02 Service Line Valves

Valves shall be according to AWWA C800. Type, pressure class, and end connections shall be as specified in the Contract Documents.

441.05.09.03 Gate Valves

Gate valves shall be according to AWWA C509.

Stem sealing on non-rising stem valves shall use O-ring type seals that do not require adjustment.

The gate valve end configuration shall be as specified in the Contract Documents.

441.05.09.04 Butterfly Valves

Butterfly valves shall be according to AWWA C504.

Valves shall be short body flanged or mechanical-joint, class 150B.

Valve shafts shall be stainless steel and, when they project through the body, shall have seals that do not require adjustment.

A vertical operating nut shall be provided. Valves shall be provided with an external indicator showing valve position by means of a pointer operating through a 90% arc from open to close.

441.05.09.05 Air Release and Air/Vacuum Valves

Air release and air/vacuum valves shall be single acting type.

441.05.10 Hydrants

Hydrants shall be according to AWWA C502. The type shall be as specified in the Contract Documents.

441.05.11 Double Check Valve Backflow Preventers

Double check valve backflow preventers shall be according to CSA B64.5 or AWWA C510.

441.05.12 Service Connection Fittings and Appurtenances

Main stops, curb stops, couplings, service boxes, and service saddles shall be as recommended by the manufacturer of the service connection pipe.

441.05.13 Concrete

Concrete for thrust blocks and fitting and appurtenance supports shall be according to OPSS 1350 with a nominal minimum 28-Day compressive strength of 20 MPa.

441.05.14 Mortar

Mortar for joints shall be composed of one part Portland cement and three parts mortar sand, wetted with sufficient water to make the mixture plastic.

The mortar sand shall be according to OPSS 1004, the Portland cement shall be according to OPSS 1301, and the water shall be according to OPSS 1302.

441.05.15 Straps, Tie-Rods, Angles, Nuts, and Bolts

Stainless steel straps, tie-rods, angles, nuts, and bolts used with concrete thrust blocks shall be according to ASTM A 276, Type 316 stainless steel.

441.05.16 Corrosion Protection

Corrosion protection shall be according to OPSS 442.

441.07 CONSTRUCTION

441.07.01 General

The work for the installation of watermain shall include all watermain pipe, bends, tees, fittings, and thrust restraints and the testing of the watermain system.

The interior of all pipe, fittings, and other accessories shall be kept clean and free from undesirable material at all times.

441.07.02 Site Preparation

Site preparation shall be according to OPSS 490.

441.07.03 Removals

Removals shall be according to OPSS 510.

441.07.04 Preservation and Protection of Existing Facilities

Preservation and protection of existing facilities shall be according to OPSS 491.

441.07.05 Protection Against Floatation

Damage to the pipeline due to floatation shall be prevented during construction and until completion of the works.

441.07.06 Cold Weather Work

All work shall be protected from freezing. Pipe and bedding material shall not be placed on frozen ground.

441.07.07 Transporting, Unloading, Storing, and Handling Pipe

All pipe, fittings, and gaskets that are unsound or damaged shall be rejected.

All pipe up to and including 600 mm diameter shall be delivered to the Work Area with end covers and a tamper evident seal on only the bell end. These components shall adhere sufficiently to withstand the stresses caused during shipment.

A waterproof seal is not required on the end covers.

Tamper evident seals shall display the manufacturers name or logo or both. Seals shall straddle the end cover and the pipe. Removal of the cover shall render the tamper evident seal unusable either by breaking the seal or by leaving a message such as "VOID" on the pipe. Tamper evident seals are not required for non-reusable heat shrink plastic covers or foam plugs with punch-out centres.

Pipe delivered to the construction site with damaged or missing end covers shall be field cleaned to remove all undesirable material along the entire length of the interior of the pipe and the end covers reinstalled.

Manufacturer's recommendations for transporting, unloading, storing, and handling of materials shall be followed.

441.07.08 Excavation

Excavation for the installation of watermain shall be according to OPSS 401.

441.07.09 Support Systems

Support systems shall be according to OPSS 404.

441.07.10 Dewatering

Dewatering shall be according to OPSS 517.

441.07.11 Temporary Protection Systems

The construction of temporary protection systems shall be according to OPSS 539.

When the stability, safety, or function of an existing roadway, railway, watercourse, other works, or proposed works may be impaired due to the method of operation, protection shall be provided. Protection may include sheathing, shoring, and piling when necessary to prevent damage to such works or proposed works.

441.07.12 Temporary Potable Water Supply Services

Temporary potable water supply services shall be according to OPSS 493.

441.07.13 Backfilling and Compacting

Backfilling and compacting shall be according to OPSS 401.

441.07.14 Installation of Pipe

Pipe shall be laid in a dry trench.

Pipe shall be laid within the alignment and grade tolerances specified in the Contract Documents. The barrel of each pipe shall be in contact with the shaped bed throughout its full length.

When the Owner raises or lowers the invert of a watermain by up to 150 mm, it shall not constitute a Change in the Work and no adjustment shall be made to the payment. When the invert of a watermain is raised or lowered by more than 150 mm, then this shall constitute a Change in the Work for the full extent of the change from the original grade.

Pipe shall be kept clean and dry as work progresses. A removable watertight bulkhead shall be installed at the open end of the last pipe laid whenever work is suspended.

Pipe shall not be laid until the preceding pipe joint has been completed and the pipe carefully embedded and secured in place.

441.07.15 Jointing

441.07.15.01 General

End covers shall be removed immediately prior to jointing. Joint surfaces shall be clean. Pipe ends shall be lubricated with material recommended by the pipe manufacturer.

Manufacturer's instructions for jointing pipe shall be followed.

Joints and all connections shall be made watertight.

All bolts, nuts, couplings, rubber rings, and connecting pieces shall be cleaned thoroughly before installation.

Pipe shall be aligned on centreline to previously laid pipe.

Pipe shall be pulled or pushed only by a hand-operated winch. A backhoe shall not be used for pushing pipe.

Joints shall be prevented from opening after the pipe has been laid.

441.07.15.02 Ductile Iron Pipe

Mechanical Joints:

The gland shall be positioned on the pipe with the lip extension toward the joint. The gasket shall be slipped on the pipe with the thick edge towards the gland. The spigot end shall be pushed to its seat in the bell. The gasket shall be pressed to seat it evenly around the joint.

The gland shall be positioned for bolting and the bolts shall be inserted. All nuts shall be hand tightened.

The nuts shall be tightened half a turn at a time with a calibrated torque wrench. All nuts shall be tightened uniformly to the torque specified in AWWA C111/A21.11.

Bell and Spigot Joints:

The gasket shall be placed in the groove of the bell making certain it is properly seated.

The gasket shall be lubricated.

Pipe to be joined shall be aligned and the spigot shall be carefully entered into the bell until the spigot end just makes contact with the gasket.

The entry of the spigot into the bell shall be completed by hand or by the use of a hand operated winch until the second reference mark is flush with the face of the bell.

441.07.15.03 Concrete Pressure Pipe

Bell and Spigot Joints:

A cotton or burlap diaper shall be placed around the bell end of the pipe already in place.

A rubber gasket shall be placed on the spigot end of the pipe to be laid ensuring that the stretch and volume of the gasket is equalized around the entire circumference of the pipe. The gasket and spigot shall be lubricated prior to the spigot end being inserted home into the bell end.

The pipe shall be aligned and the spigot end shall be inserted into the bell of the pipe already in place.

Steel inserts shall be placed in the joints to prevent the spigot from entering the full depth of the bell. The location of the rubber gasket shall be checked around the entire circumference of the joint. The steel insert shall be removed and the pipe pushed until the spigot enters the full depth of the socket and is retained in position.

Ensure that the diaper is carefully placed around the joint recess. Cement mortar shall be poured around the assembled joint.

441.07.15.04 Polyvinyl Chloride Pressure Pipe - PVC and PVCO

Joints shall be bell and spigot with rubber gaskets. If gaskets are supplied separately, they shall be inserted in the groove of the bell end of the pipe.

The spigot shall be lubricated. The spigot end shall be inserted and pushed into the bell up to but not beyond the depth of the stop reference mark.

441.07.15.05 Polyethylene Pressure Pipe

Polyethylene pipe 100 mm diameter and larger shall be joined by the thermal butt fusion process. Procedures recommended by the pipe manufacturer shall be followed.

Polyethylene pipe 75 mm diameter and smaller shall be joined with heat fusion or insert or compression type fittings that are recommended by the pipe manufacturer and that prevent pull-out and resist creep deformation at full test pressure.

Connections to non-polyethylene fittings and appurtenances 50 mm diameter and larger shall be made with flanged joints according to the manufacturer's recommendations. Bolts shall be tightened to the torque specified by the manufacturer for the particular size and type of stub end.

441.07.15.06 Steel Pipe

Steel pipe shall be jointed according to AWWA C200. Field welding for joints shall be according to AWWA C206.

441.07.15.07 Service Connection Pipe

Service connection pipe shall be jointed as recommended by the manufacturer.

441.07.16 Cutting of Pipe

Whenever cutting of pipe is required, the pipe shall be cut according to the recommendations of the pipe manufacturer. After cutting the pipe, the interior of the pipe shall be cleaned and the end cover replaced until the pipe is installed.

441.07.17 Change in Line and Grade

441.07.17.01 Ductile Iron Pipe

Fabricated bends shall be provided for changes in line and grade of 11.25° or more.

Deflections of less than 11.25° may be made using a series of pipe joint deflections. The manufacturer's recommendation in deflecting any single pipe joint shall not be exceeded.

441.07.17.02 Concrete Pressure Pipe

Fabricated bends, bevel adaptors, or elbows shall be used for changes in line or grade greater than 5°. Changes in line or grade less than 5° shall be made using a manufactured joint or bevel connection or may be made over several joints. The manufacturer's joint deflection recommendations shall not be exceeded.

441.07.17.03 Polyvinyl Chloride Pipe - PVC and PVCO

Polyvinyl chloride pipe joints may be deflected but shall not exceed the manufacturer's recommendations. Otherwise, fabricated bends shall be used.

441.07.17.04 Polyethylene Pipe

Use of pipe flexibility may be allowed but shall not exceed the manufacturer's recommendations.

441.07.17.05 Steel Pipe

Fabricated bends shall be used at all changes in line or grade, unless the change can be accomplished by deflections at pipe joints without exceeding the manufacturer's recommendation for deflection at pipe joints.

441.07.18 Installation of Valves and Fittings

441.07.18.01 General

The work for the installation of valves and fittings shall include the valves and couplings and valve boxes, when valve boxes are specified in the Contract Documents. Valves and fittings shall be installed in locations and be of the type specified in the Contract Documents. Valves and connecting pipe shall be aligned accurately and supported as specified in the Contract Documents. Valves and fittings do not require end covers but shall be field cleaned prior to installation.

441.07.18.02 Air Release and Air/Vacuum Valves

Air release and air/vacuum valves shall be installed at locations specified in the Contract Documents.

Each air release and air/vacuum valve shall be provided with an isolating valve.

441.07.19 Installation of Hydrant Sets

The work for the installation of hydrant sets shall include the placing of hydrants, hydrant isolating valves, hydrant leads, restraining devices, and support devices.

Hydrant sets shall be installed at locations specified in the Contract Documents.

The hydrant shall be plumb with the nozzles parallel to the edge of pavement or curb line and the pumper connection facing the roadway.

441.07.20 Installation of Service Connections

A service connection shall consist of a service connection pipe and a service connection appurtenance set and shall be installed at locations and be of the size specified in the Contract Documents.

Service connection pipe shall be installed by pressure tap connection or saddles. Service connections on plastic watermain shall be installed using service saddles or tapped couplings.

Curb stop valve boxes shall be installed vertically and flush with the final grade elevation.

441.07.21 Shutting Down or Charging Mains

At no time shall watermain be shut down or charged or valves operated without permission from the Contract Administrator.

441.07.22 Connections to Existing Watermain

The work of connecting to existing watermain shall include the removal of all plugs, caps, blow offs, and thrust blocks from an existing watermain or fitting, and the installation of the connection.

All connections to existing watermain shall be made under the supervision of the Contract Administrator.

441.07.23 Thrust Restraints

All connections, caps, and bends shall be restrained by concrete blocking and/or restrained joints as specified in the Contract Documents. Concrete for thrust blocks shall be placed against undisturbed ground. Joints and couplings shall remain free from concrete. Only restrained joint products specifically designed for use with the pipe material shall be used.

441.07.24 Hydrostatic Testing

441.07.24.01 General

Hydrostatic testing shall be conducted under the supervision of the Contract Administrator upon completion of the watermain, including services and backfilling.

A test section shall be either a section between valves or the completed watermain.

Test pressure shall be 1,035 kPa.

The test section shall be filled slowly with water and all air shall be removed from the pipeline. A 24-hour absorption period may be allowed before starting the test. The test section shall be subjected to the specified continuous test pressure for 2 hours.

441.07.24.02 Polyethylene Pipe

The test procedure shall consist of initial expansion and test phases.

During the initial expansion phase, the test section shall be pressurized to the test pressure and sufficient make-up water added each hour for 3 hours to return to test pressure. The test phase begins after the initial expansion phase.

The test phase shall be 2 hours after which a measured amount of make-up water is added to return the test pressure. If the amount of make-up water added does not exceed the value in Table 1, leakage is not indicated.

If the amount of make-up water exceeds the Table 1 value, all leaks shall be located and repaired and the test section shall be retested until a satisfactory result is obtained.

The test duration should not exceed 8 hours. If the pressure test is not completed, the test section shall be de-pressurized and allowed to relax for at least 8 hours before bringing the test section up to pressure again.

441.07.24.03 Other Pipe

A period of 24 hours shall be allowed before starting the test.

The test section shall be subject to the specified continuous test pressure for 2 hours.

The leakage is the amount of water added to the test section to maintain the specified test pressure for the test duration. The measured leakage shall be compared with the allowable leakage as calculated for the test section. The allowable leakage is 0.082 litres per millimetre of pipe diameter per kilometre of pipe

for the 2-hour test period.

If the measured leakage exceeds the allowable leakage, all leaks shall be located and repaired and the test section shall be retested until a satisfactory result is obtained.

441.07.25 Flushing and Disinfecting Watermains

Flushing and disinfecting operations shall be in accordance with the MOECC Watermain Disinfection Procedure.

441.07.26 Site Restoration

Site restoration shall be according to OPSS 492.

441.07.27 Management of Excess Material

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

All chlorinated water used for testing, flushing, or disinfecting watermains shall be disposed of safely.

The method of disposal of chlorinated water is subject to the approval of the Contract Administrator.

441.09 MEASUREMENT FOR PAYMENT

441.09.01 Actual Measurement

441.09.01.01 Watermains

Measurement of watermains shall be by length in metres along the horizontal centreline of the pipe from the point of connection to a chamber, water treatment plant, or existing watermain to a point vertically above the end of the new watermain.

441.09.01.02 Valves

For measurement purposes, a count shall be made of the number of valves installed, regardless of the type and size.

441.09.01.03 Hydrant Sets

For measurement purposes, a count shall be made of the number of hydrant sets installed, regardless of the type.

441.09.01.04 Service Connection Pipe

Measurement of service connection pipe shall be by length in metres along the horizontal centreline of the pipe from the point of connection at the watermain to a point vertically above the end of the service connection.

441.09.01.05 Service Connection Appurtenance Sets

For measurement purposes, a count shall be made of the number of service connection appurtenance sets installed.

441.09.01.06 Connections to Existing Watermains

For measurement purposes, a count shall be made of the number of connections made to existing watermains.

441.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

441.10 BASIS OF PAYMENT

- 441.10.01 Watermains - Item**
Valves - Item
Hydrant Sets - Item
Service Connection Pipe - Item
Service Connection Appurtenance Sets - Item
Connections to Existing Watermains - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

TABLE 1
Test Phase Make-Up Amount for Pressure Polyethylene Pipe

Pipe Diameter mm	Make-Up Water litre/km
30	12.38
40	12.38
50	13.62
75	18.60
100	31.00
150	74.50
200	124.20
250	161.40
275	248.30
300	285.60
350	335.20
400	409.70
450	533.90
500	682.90
550	869.10
600	1,105.00
700	1,378.20
800	1,775.50
900	2,234.90
1,000	2,731.60
1,050	3,104.00
1,200	3,973.20
1,350	5,152.70
1,600	7,449.70

Appendix 441-A, Commentary for OPSS.MUNI 441, November 2016 FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

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

Designer Action/Considerations

The designer may consider including soil boring data, a geotechnical report, a subsurface report, or a soils report in the Tender Documents.

The designer should include the following in the Contract Documents:

- Pipe size, type, and class. (441.05.01)
- Service line valve type, pressure class, and end connections. (441.05.09.02)
- Gate valve end configuration. (441.05.09.03)
- Type of hydrants. (441.05.10)
- Alignment and grade tolerances for the pipe installation. (441.07.14)
- Valve type and location. (441.07.18.01)
- Air release and air/vacuum valve locations. (441.07.18.02)
- Location of hydrant sets. (441.07.19)
- Location and size of service connections. (441.07.20)
- Thrust restraints. (441.07.23)

The designer should determine if valve boxes are needed and, if so, they should be specified in the Contract Documents. (441.07.18.01)

Tracer wire or tracer tape should be specified, if appropriate.

Under conditions of high ground water, external fluids may enter via air release and air/vacuum release valves; therefore, appropriate measures should be taken.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Appendix 441-A

Related Ontario Provincial Standard Drawings

OPSD 1101.012	Precast Concrete Valve Chamber with Poured-In-Place Thrust Blocks, 1800 x 2400 mm, Components
OPSD 1101.013	Precast Concrete Valve Chamber with Poured-In-Place Thrust Blocks, 1800 x 2400 mm, Riser and Base
OPSD 1101.014	Precast Concrete Valve Chamber with Poured-In-Place Thrust Blocks, 1800 x 2400 mm, Thrust Blocks
OPSD 1101.015	Precast Concrete Valve Chamber with Poured-In-Place Thrust Blocks, 1800 x 2400 mm, Chimney and Cap
OPSD 1101.016	Precast Concrete Valve Chamber with Poured-In-Place Thrust Blocks, 2400 x 3000 mm, Components
OPSD 1101.017	Precast Concrete Valve Chamber with Poured-In-Place Thrust Blocks, 2400 x 3000 mm, Riser and Base
OPSD 1101.018	Precast Concrete Valve Chamber with Poured-In-Place Thrust Blocks, 2400 x 3000 mm, Thrust Blocks
OPSD 1101.019	Precast Concrete Valve Chamber with Poured-In-Place Thrust Blocks, 2400 x 3000 mm, Chimney and Cap
OPSD 1101.020	Valve Operator
OPSD 1101.030	Precast Concrete Valve Chamber With Poured-in-Place Thrust Blocks, 3000 x 3000 mm Components
OPSD 1101.031	Precast Concrete Valve Chamber With Poured-in-Place Thrust Blocks, 3000 x 3000 mm Riser and Base
OPSD 1101.032	Precast Concrete Valve Chamber With Poured-in-Place Thrust Blocks, 3000 x 3000 mm Thrust Blocks
OPSD 1101.033	Precast Concrete Valve Chamber With Poured-in-Place Thrust Blocks, 3000 x 3000 mm Chimney and Cap
OPSD 1101.040	Precast Concrete Valve Chamber With Poured-in-Place Thrust Blocks, 3600 x 3000 mm Components
OPSD 1101.041	Precast Concrete Valve Chamber With Poured-in-Place Thrust Blocks, 3600 x 3000 mm Riser and Base
OPSD 1101.042	Precast Concrete Valve Chamber With Poured-in-Place Thrust Blocks, 3600 x 3000 mm Thrust Blocks
OPSD 1101.043	Precast Concrete Valve Chamber With Poured-in-Place Thrust Blocks, 3600 x 3000 mm Chimney and Cap
OPSD 1103.010	Concrete Thrust Blocks for Tees, Plugs, and Horizontal Bends
OPSD 1103.020	Concrete Thrust Blocks for Vertical Bends
OPSD 1104.010	Water Service Connection, 19 and 25 mm Diameter Sizes
OPSD 1104.020	Water Service Connection, 32, 38, and 50 mm Diameter Sizes
OPSD 1104.030	25 mm Blow Off Installation
OPSD 1105.010	Hydrant Installation
OPSD 1107.010	Piping Layout for Water Meters 50 mm and Smaller in Chambers
OPSD 1107.020	Piping Layout for Water Meters 75 to 250 mm in Chambers with By-Pass
OPSD 1107.030	Piping Layout for Water Meters in Building with By-Pass
OPSD 1108.010	Cast-In-Place Water Meter Chamber for 75 to 250 mm Meters
OPSD 1109.010	Cathodic Protection for Metallic Watermain Systems
OPSD 1109.011	Cathodic Protection for PVC Watermain Systems
OPSD 1109.012	Cathodic Protection off Existing Metallic Watermains, Exposed Service or Pipe Method
OPSD 1109.013	Anode Installation Over Pipe Method for Existing Metallic Watermains
OPSD 1109.014	Horizontal Anode Bank at Service
OPSD 1109.015	Vertical Anode Bank at Service
OPSD 1109.025	Waterproofing of Splices



**CONSTRUCTION SPECIFICATION FOR
CORROSION PROTECTION OF NEW AND
EXISTING WATERMAINS**

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442.01 SCOPE

This specification covers the requirements for providing corrosion protection to watermains and their metallic components using galvanic anodes, or petrolatum or petroleum wax tape coating systems, or both methods in typical soil conditions on new PVC watermains, new metallic watermains, and existing metallic watermains. Galvanic anode methods include the over pipe method, anode bank method, and exposed watermain methods.

This specification also covers the requirements for corrosion monitoring for concrete pressure pipe.

442.01.01 Specification Significance and Use

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

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

442.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

442.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 441	Watermain Installation in Open Cut
OPSS 490	Site Preparation for Pipelines, Utilities, and Associated Structures
OPSS 492	Site Restoration Following Installation of Pipelines, Utilities, and Associated Structures

CSA Standards

C22.2 No. 197-M1983 (2013) PVC Insulating Tape

ASTM International

B 418-14	Cast and Wrought Galvanic Zinc Anodes
B 843-09	Magnesium Alloy Anodes for Cathodic Protection
G 97-97(2013)	Standard Test Method for Laboratory Evaluation of Magnesium Sacrificial Anode Test Specimens for Underground Applications

American Water Works Association (AWWA)

C217-09	Petrolatum and Petroleum Wax Tape Coatings for the Exterior of Connections and Fittings for Steel water Pipelines

Underwriters Laboratories of Canada (ULC)

UL 467-09	Grounding and Bonding Equipment

442.03 DEFINITIONS

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

Anode means the electrode of an electrochemical cell where corrosion occurs and metal ions enter solution. An anode refers to a packaged anode consisting of the casting, chemical packing material, lead wire, tube, and label.

Anode Chemical Packing means select materials used to surround an anode in its tube in order to improve current efficiency, reduce local corrosion of the anode casting, help keep the anode moist, and increase the effective anode size and, for zinc, prevent the passivation of the anode.

Anode Type means both the material and the size of the anode shown in Table 1, which is included in the A-WW-LL label on the outside of the anode. The A location indicates the casting alloy material, Z for zinc and M for magnesium. The WW indicates the weight of the casting in pounds and the LL indicates the length of the casting in inches.

Associated Appurtenances means structures, devices, and appliances, other than pipe and conduit that are used in connection with a water distribution system, such as valves, hydrants, saddles, corporation and main stops, curb stops, services, and thrust restraints.

Backfill means material placed in a hole to fill the space around the anodes and other portions of the project.

Bonding means the joining of metallic components together to ensure complete electrical continuity throughout the piping system.

Cathodic Protection means a technique to control the corrosion of a metal surface by making that surface the cathode of an electrochemical cell.

Certified Cathodic Protection Specialist means a person that has received Cathodic Protection Specialist Certification by NACE International.

Coating means a dielectric material applied to a structure to separate it from the environment.

Corrosion Protection means corrosion control of a metal surface either by coatings or cathodic protection or both.

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

Fittings means as defined in OPSS 441.

Galvanic Anode means a metal that provides protection to metals that are more noble in the galvanic series when coupled in an electrolyte. This is in contrast to impressed current anode systems that use an external direct current power source between the cathode and anode bed.

Ground Clamp means a copper clamp device used to connect a wire to copper service tubing in order to create an electrical connection to earth.

Holiday means a discontinuity in the coating.

Mastic means a cold applied self-supporting petrolatum compound containing beads of closed cell polymer and flow control additives for molding irregular shapes.

Metallic Components means metallic hydrants, valves, fittings and associated appurtenances designed to be used in connection with pipes.

Metallic Watermain or Pipe means a ductile iron, cast iron, or steel watermain pipe, excluding copper services.

Negative Lead means the wire running from the watermain or service pipe to the test station.

Petrolatum means a purified mixture of semisolid hydrocarbons obtained from petroleum jelly.

Petroleum Wax means a refined mixture of solid hydrocarbons, paraffinic in nature, obtained from petroleum. It may be prepared as a refined paraffin wax or as a microcrystalline wax.

Primer means a soft compound of petrolatum or petroleum wax containing moisture displacing corrosion inhibiting compounds.

Tape means a cold applied saturant tape made from either petrolatum or petroleum wax and a noncellulosic synthetic fiber fabric.

Tape Coating System means the finished product consisting of the petrolatum or petroleum wax primer, mastic, where applicable, and tape.

Test Station means a pole or flush mounted terminal that is used to conveniently monitor electrical currents and potentials associated with galvanic cathodic protection systems.

Thermite Weld means a permanent low resistance electrical connection made by a powder welding process using an exothermic copper-depositing mixture ignited in a graphite mold.

Watermains means as defined in OPSS 441.

442.05 MATERIALS

442.05.01 Zinc and Magnesium Anodes

442.05.01.01 Zinc Anode Castings

Zinc anode castings shall have a high potential alloy composition according to ASTM B 418, Type II.

442.05.01.02 Magnesium Anode Castings

Magnesium anode castings shall have a composition according to ASTM B 843, Type M1-C, and have a minimum current efficiency of 50% and shall be according to ASTM G 97.

442.05.01.03 Steel Core of Anode Castings

The steel core of the anode castings shall be electro-galvanized and extend 75% of the anode length.

442.05.02 Anode Packaging

The magnesium and zinc anode castings shall be supplied complete with an anode lead wire and shall be centred in and surrounded by chemical packing material. The anode casting and chemical packing shall be contained within a biodegradable, water permeable cardboard tube of sufficient durability to permit normal handling without appreciable damage. Anode castings and overall packaging shall meet the requirements specified in Table 1.

442.05.02.01 Anode Chemical Packing Composition

The chemical packing material shall have an electrical resistivity of less than 45 ohm-cm when saturated with distilled water, a compacted density of 1.5 g/cm³, and the following composition:

<u>Chemical Packing Component</u>	<u>% by Volume</u>
Gypsum	77 ± 2%
Bentonite	15 ± 1%
Sodium Sulphate	8 ± 1%

442.05.02.02 Labelling

All anodes shall be labelled on the outside of the cardboard tube indicating the type and the specification designation OPSS 442, as follows:

a) For each zinc anode, each tube shall be labelled as follows:

A-WW-LL Anode According to OPSS 442 (e.g., Z-6-12 Anode According to OPSS 442)

b) For each magnesium anode, each tube shall be labelled as follows:

A-WW-LL Anode According to OPSS 442 (e.g., M-17-20 Anode According to OPSS 442)

The letters shall be a minimum of 25 mm in height.

442.05.03 Petrolatum and Petroleum Wax Tape Coatings

Petrolatum and petroleum wax tape coating system components shall be according to the material requirements of AWWA C217.

442.05.04 Wires

Bond wires shall be 450 mm in length with TWU or RWU-90 black insulation with AWG #4/7 strand copper wire or, when specified, AWG #1/0 - 19 strand copper wire.

Anode wires shall be 3.0 m in length of AWG #10/7 strand copper wire having RWU-90 insulation, blue for magnesium anodes, and white for zinc anodes, and shall be silver soldered to the steel core of the anode casting.

Anode header wires for anode banks shall be AWG #10/7 strand wire with red RWU-90 insulation.

Negative wires from test stations to ground clamps or pipe shall be AWG #10/7 strand wire with RWU-90 black insulation.

Wire for corrosion monitoring probes for concrete pressure pipe shall be AWG #10/7 strand wire with RWU-90 black insulation.

Wire for connecting the watermain negative wires from the pipe joint bonding wire of concrete pressure pipe to the test station shall be AWG #4/7 strand wire with RWU-90 black insulation.

442.05.05 Test Stations

Each test station shall consist of a non-conductive housing and lid and shall be either flush-mounted or post-mounted as specified in the Contract Documents. The lid shall be supplied with a stainless steel locking bolt and an Allen key head and shall be blue in colour. The terminal board shall include 5 stainless steel terminals and one nickel plated copper bonding or shorting strap. All terminals shall have two stainless steel nuts for locking purposes.

- a) Flush-mounted test stations shall be mounted on a 300 mm length of 150 mm diameter UV stabilized polyethylene or polycarbonate pipe.
- b) Post-mounted test stations shall be mounted on a 1,500 mm length of 32 mm diameter PVC or UV stabilized polyethylene pipe and fastened securely to a suitable support.

442.05.06 Thermite Welds

The thermite weld material shall be as follows:

Thermite Molds or Welders:

- a) Shall be suitable for the wire, connection type, and orientation.
- b) Shall have a handle and lid.
- c) Shall be made of graphite or synthetic graphite, be able to withstand high temperatures, and be designed to provide an average life of not less than 50 separate exothermic welds.
- d) Shall be from the same manufacturer as the weld metal.

Thermite Powder Cartridges:

- a) Shall be suitable for the pipe material.
- b) Weld metal shall contain vanadium, but not tin.
- c) Weld metal shall be sealed in a suitable capsule and be identified with the part number and size and type of metals to be connected, such as copper to steel or copper to ductile iron.
- d) The batch control numbers shall be packaged with the product prior to shipment from the factory.

Starting Material:

- a) When used, shall consist of aluminum, copper, and iron oxide materials. It shall not contain phosphorous or any caustic, toxic, or explosive substances.

- b) When used, shall be electrical igniters that have a lead length of 1.83 m or greater and use an electric ignition system that does not use spark ignition material.

Thermite Weld Protective Barrier Covers:

- a) Shall be moulded plastic domes filled with corrosion resistant compound on a base of thick elastomeric tape.
- b) Shall use an integrated primer in its adhesive.

Thermite Weld Protective Barrier Coatings:

- a) Shall bond firmly to surfaces without the use of primers and form a tough coating resistant to oxidizing, cracking, alligatoring, checking, loosening, or scaling.
- b) Shall be composed of heavy mastic with synthetic elastomeric additives in mixed solvent.

442.05.07 Miscellaneous Materials

Ground clamps for copper water services shall be UL 467 listed for direct burial, high strength, high conductivity, and a minimum of 80% copper alloy.

Direct Bury Lugs:

- a) Shall be one piece, high impact housing, pre-filled with silicone providing waterproof and corrosion proof protection and be designed for long term direct bury applications.
- b) Shall be able to connect to header wire without cutting the header wire.
- c) Shall tighten with a screwdriver.
- d) Shall have high impact housing without sharp edges to prevent cuts or handling discomfort.
- e) Shall be designed for use with wires from #14 to #10 AWG or larger and under 50 volts.

Wire splicing kits for cathodic protection systems shall be waterproof and suitable for direct bury applications.

C Taps shall be as specified in the Contract Documents.

The solder shall be 60% tin and 40% lead mix, resin core type.

Moisture proofing shall be fast drying sealant and bonding compound specifically designed for coating electrical connections.

Insulating putty shall be dielectric, easy to handle and apply, have excellent adhesion to surfaces, and be suitable for filling voids and irregular surfaces.

Self-amalgamating tape shall be made using modified silicone rubber compound that forms a moisture-proof abrasion-resistant bond. Tape shall have high dielectric strength, adhering to itself creating an immediate permanent bond even when wet.

Rubber splicing tape shall be 25 mm wide waterproof neoprene.

Electrical tape shall be 25 mm wide PVC electrical tape, rated for 600 V with a working temperature of -10 to 90 °C, and according to CSA C22.2 No. 197.

442.07 CONSTRUCTION

442.07.01 General

The methods for corrosion protection shall be as specified in the Contract Documents.

Anodes shall be installed complete with their cardboard tube container and enclosed chemical packing.

442.07.02 Site Preparation

Site preparation shall be according to OPSS 490.

442.07.03 Transporting, Unloading, Storage, and Handling Materials

Anodes and other materials that can be damaged by exposure to the elements shall be stored in a clean dry secured enclosure until installation.

Anodes shall not be carried or lowered by their lead wires.

442.07.04 Anode Installation

442.07.04.01 Existing Metallic Watermains - Over Pipe Method

Prior to installation, the location for each anode and test station shall be marked with a white stake or white paint on paved areas and shall be approved by the Contract Administrator.

Anodes shall be of the type and spacing specified in Table 2. The first anode at each end of the watermain shall be within 3.0 m of the end of the watermain.

Anode locations may be shifted a maximum of 3.0 m to avoid driveways and other paved areas.

Each anode site shall be excavated with an auger or a vacuum excavator to expose the top of the pipe and accommodate the anode to be installed. The diameter of the hole shall be a maximum of 500 mm.

The anode wire shall be thermite welded to the metallic pipe and the connection protected.

The excavation shall be partially backfilled with native backfill so that the anode shall reside 300 mm above the watermain.

The excavation shall be backfilled with material matching the existing subgrade that shall be manually compacted and thoroughly watered. Granular subbase and base profiles shall be reinstated above the subgrade.

442.07.04.02 Existing Metallic Watermains - Anode Bank Method

The anode bank method applies to both vertical and horizontal anode banks for the purpose of retrofitting existing metallic watermains with cathodic protection.

Anodes and anode banks shall be of the type and spacing specified in Table 3.

Anode banks shall be installed on the side of the street opposite to the watermain. Anodes shall be installed so the centre of the anode is at the same depth as the service to which they are being attached or a minimum of 2.0 m below the finished grade, whichever is greater.

Each anode site shall be excavated with an auger or a vacuum excavator to expose the top of the pipe and accommodate the anode to be installed. The diameter of the hole shall be a maximum of 500 mm.

The anode leads shall be spliced to the header wires using one of the approved wire splicing methods.

442.07.04.03 Existing Metallic Watermains - Exposed Pipe or Service Method

The exposed pipe or service method applies when an existing watermain is not cathodically protected, and when the existing watermain or water services are exposed during the course of other work (e.g., another Utility installation or watermain break repair).

Anodes to be used for this application shall be magnesium type M-32-22.

Anodes shall be installed at least 1.5 m horizontally away from the watermain pipe and as deep as the bottom of the excavation. Anodes shall be spaced as far apart in the trench as the wires and trench permit.

The anode lead shall be electrically connected to the water piping by connecting to either:

- a) A copper or lead service pipe using a ground clamp.
- b) The watermain using the thermite weld procedure.

442.07.04.04 New Metallic Watermains and Copper Services

Anodes shall be of the type and spacing specified in Table 4.

Anodes shall also be installed as follows:

- a) On the lateral piping of each hydrant.
- b) At each metallic component.

Anodes shall be installed at least 1.0 m horizontally away from the watermain or service pipes and as deep as the bottom of the pipes. The minimum distance between anodes shall be 1.0 m.

442.07.04.05 New Polyvinyl Chloride Watermains with Metallic Components

Anodes shall be of the type and spacing specified in Table 5.

Anodes shall be installed at least 1.0 m horizontally away from the metallic component and as deep as the bottom of the metallic component. The minimum distance between anodes shall be 1.0 m.

442.07.04.06 New Watermains with Metallic Components

All metallic components specified in the Contract Documents shall be protected using corrosion protection methods as specified in the Contract Documents.

442.07.05 Corrosion Monitoring for Concrete Pressure Pipe

The locations for corrosion monitoring test stations shall be as specified in the Contract Documents.

All concrete watermains shall include bonding wires connected by thermite weld to provide electrical continuity. Galvanic zinc anodes are recommended.

All concrete pressure pipe sections, including pipe within jacking and boring encasement pipe and all bevel and bend fittings shall have two electrical bonding connections on each side, located 45° off the vertical.

Corrosion test monitoring stations for concrete pressure pipe shall include three probes or pipe coupons at each station. The probes shall be connected to the test monitoring station with approved wire.

442.07.06 Test Station Installation - General

Test stations shall be installed at locations as follows:

- a) Where they do not interfere with or present a hazard to pedestrian or vehicular traffic and at the nearest property line, whenever possible.
- b) For new metallic watermain, over pipe method, and concrete pressure pipe, at each hydrant and, if there are no hydrants, start within 20 m of the project limit and locate at 150 m intervals along the watermain.
- c) At each anode bank.

Flush-mounted test stations shall be installed flush with the ground, sidewalk, or pavement surface. Post-mounted test stations shall be mounted so that the top of the cover is 600 mm above the surface.

The anode lead may be extended using an additional length of the same type of wire spliced with an approved splice connection method.

Except for corrosion monitoring applications, test station connections shall be as follows:

- a) The two negative leads shall be brought into the test station and connected to terminals 2 and 3.
- b) Terminal 1 shall be connected to Terminal with a bonding strap.
- c) No bonding strap shall be connected to terminal 3 or 4.

Sufficient wire slack of 0.5 m in the housing below the panel shall be left in the wires to prevent any stress on either during backfilling and subsequent soil settlement and for withdrawing the terminal panel, if necessary during test work.

442.07.06.01 Test Station Connections for New Metallic Watermains

The lead wire of the anode nearest to the test station shall not be welded directly to the pipe, but instead shall be brought into the test station and connected to terminal 1.

Two watermain negative wires shall be thermite welded to the crown of the watermain pipe 150 mm apart and the other ends of the wires shall be connected according to the Test Station Installation - General subsection.

442.07.06.02 Test Station Connections for Anode Banks

The header wires shall be brought into the test station and connected to terminal 1.

Two watermain negative wires shall be attached to the metallic service line, each with their own ground clamp and the other ends of the wires shall be connected according to the Test Station Installation - General subsection.

442.07.06.03 Test Station Connections for Corrosion Monitoring

Two watermain negative wires shall be connected to the concrete pressure pipe joint bonding wires with an approved splice connection method. The other ends of the wires shall be connected to terminals 1 and 2 of the test station. The three probe or pipe coupon wires shall be brought into the test station and connected to terminals 3, 4, and 5.

442.07.07 Thermite Weld Connections

All wire connections to metallic surfaces shall be made by means of a thermite weld method according to the following procedure:

- a) Remove all coating, and clean bright and thoroughly dry a 75 mm² metal welding surface .
- b) Select the proper mould for the application.
- c) Insert bared end of wire into mould. A reinforcing sleeve may be required, depending on flexibility of wire. Manufacturer's instructions shall be followed.
- d) Thermite weld the anode lead to the metallic surface in accordance with the manufacturer's instructions.
- e) Remove all slag from the weld-on wire connection and file smooth all sharp edges.
- f) The integrity of each weld shall be tested by giving a sharp pull on the lead wire.

Sufficient slack shall be left in the wires to prevent any stress on either the anode or the wire-to-pipe connection during backfilling and subsequent soil settlement.

For new watermain, and where practical for existing watermain, the anode lead wire shall be wrapped around the pipe and secured with a knot. The free end of the wire shall then be thermite welded to the watermain, metallic component, or valve.

442.07.08 Thermite Weld Protection

The cleaned metallic surfaces, thermite weld, and the exposed copper wire surfaces shall all be protected with an approved thermite weld protective barrier coating or cover. Both must overlap existing coating and insulation on wire to prevent holidays in the protection.

Coating and cover shall be installed according to the manufacturer's instructions.

442.07.09 Anode and Header Wire Splicing and Waterproofing

Wire splicing to the header wire shall be accomplished without cutting the header wire.

Wire to wire splicing shall be accomplished by one of the following methods as specified in the Contract Documents:

- a) Approved C Taps.
- b) Approved direct bury lugs with built-in waterproof protection.
- c) Soldered splices.
- d) Wire-to-wire thermite weld.

Splicing products shall be suitable for the size of wire being spliced.

Prior to backfilling, all splices and connections without built-in waterproof protection shall be rendered waterproof by either careful application of the waterproof tape method or by use of a wire splicing kit designed for cathodic protection.

Waterproof tape method shall be performed as follows:

- a) Apply moisture proofing over connector and exposed wire.
- b) Apply insulating putty to break sharp corners at the connection.
- c) Apply tape in accordance with one of the following methods:
 - i. Two half-lapped layers of approved self-amalgamating tape overlapping the wire insulation.
 - ii. Four half-lapped layers of approved rubber splicing tape overlapping the wire insulation and apply four half-lapped layers of approved self-adhesive electrical tape.

When using splicing kits designed for cathodic protection systems, the kits shall be applied in accordance with manufacturer's instructions.

442.07.09.01 C Tap Splices

Prior to cutting the wire for splicing, the wire shall be loose to avoid stretching.

The wire shall be stripped about the length of the electrical connector using an appropriate stripping tool. The exposed copper wire shall be free of nicks or scores.

An approved C Tap shall then be placed over the exposed area of the wire. The connecting wire shall be carefully inserted into the C Tap up to the insulation and tightened using an approved compression tool specifically designed for C Taps. Vice-grips, pliers, battering with a hammer, etc. shall not be permitted.

The splice shall be inspected for exposed copper and snugness. Splices that fail inspection shall be cut and redone.

442.07.09.02 Direct Bury Lug Splices

Splices using direct bury lugs shall be performed in accordance with the manufacturer's instructions.

442.07.09.03 Soldered Splices

Soldered connections shall be performed in accordance with industry practices.

442.07.09.04 Tape Coating Systems

Petrolatum and petroleum wax tape coating systems shall be applied according to the procedures described in AWWA C217.

442.07.10 Electrical Bonding of Joints

442.07.10.01 New Metallic Pipe

All new metallic pipe joints, valves, and components shall be connected together with a bond wire to ensure complete electrical continuity throughout the metallic piping system. Bond wires shall be connected to the metallic surfaces using a thermite weld.

Bare copper bond straps, conductivity screws, and conductivity wedges shall not be used to provide electrical continuity. If bare copper bond straps are supplied with the piping, they shall be removed.

442.07.10.02 Existing Metallic Pipe

Bond wires shall be installed by thermite welding between all metallic components and across all joints that are exposed within the excavation.

Where a repair clamp is installed across a break, a bond wire shall be installed across the break after repair clamp installation.

Where a cut-out is required, a bond wire shall be installed.

442.07.11 Wire Connections to Copper Services

The anode lead shall be connected to copper services using a ground clamp. Ground clamps shall be attached to copper services in accordance with the manufacturer's instructions. Wires shall be connected to the ground clamps in accordance with the manufacturer's instructions.

442.07.12 Anode Backfilling

In all cases, the anode shall be placed in native soil, not in granular bedding material. The Contract Administrator shall inspect the anode installation prior to backfilling. Backfill shall be packed uniformly around the anode container to eliminate voids adjacent to the anode.

442.07.13 Testing and Evaluation

For applications using test stations, the following procedures shall be performed and recorded between 90 and 120 Days after the installation:

- a) Pipe potentials shall be measured with respect to a copper sulfate electrode at maximum intervals of 30 m throughout the route of the piping. The voltmeter employed to measure these potentials shall have an input impedance not less than 10 Mega Ohms.
- b) Potential measurement connection locations shall be made at the nearest test station to the electrode. The reference electrode and pipe connection locations employed for the potential measurements shall be identical for both the pre-construction and post-construction testing procedures. The electrical continuity of the piping shall be verified by comparison of pipe potential.
- c) During post construction testing, the following measurements shall be made at the test stations:
 - i. Anode output current.
 - ii. Pipe potential with anode connected.
 - iii. Pipe potential with anode disconnected.

All testing data and associated recommendations pertinent to the continued effectiveness of the cathodic protection system shall be included in a comprehensive written report. This report shall be prepared by an Engineer or a Certified Cathodic Protection Specialist, and shall be submitted to the Contract Administrator.

442.07.14 Site Restoration

Site restoration shall be according to OPSS 492.

442.07.15 Management of Excess Material

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

442.08 QUALITY ASSURANCE

The Contractor shall ensure that the anodes supplied are in accordance to this specification.

Prior to installing each shipment of anodes, the Contractor shall forward a copy of a certificate to the Owner from the anode manufacturer indicating that the shipment of anodes complies with the requirements of this specification.

The Owner may randomly select samples of anodes supplied by the Contractor for testing by an independent laboratory.

Any batch of anodes found not to be in accordance to this specification shall be replaced immediately by the Contractor. No additional work shall take place until such time that the anodes are approved and accepted by the Owner.

Any installed anodes found not to be in accordance to the required specifications shall be replaced by the Contractor.

442.09 MEASUREMENT FOR PAYMENT

442.09.01 Actual Measurement

442.09.01.01 Individual Anodes

For measurement purposes, a count shall be made of the number of each anode type installed, other than in an anode bank, and of the number of anodes supplied for testing.

442.09.01.02 Anode Banks

For measurement purposes, a count shall be made of the number of each anode bank type installed.

442.09.01.03 Test Stations

For measurement purposes, a count shall be made of the number of each test station type installed.

442.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

442.10 BASIS OF PAYMENT

442.10.01 "type" Individual Anode - Item "type" Anode Bank - Item "type" Test Station - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

When an existing unprotected watermain or service is exposed during the construction of other work, payment for the labour, Equipment, and Material for such work shall be full compensation for the excavation, backfill, and compaction required to install anodes on the exposed watermain or service.

Replacement of anodes that do not meet the requirements of this specification shall be the responsibility of the Contractor at no extra cost to the Owner.

TABLE 1
Table of Casting and Anode Weights and Dimensions

ANODE TYPE	CASTING		OVERALL PACKAGE	
	Minimum Weight kg	Nominal Length mm	Nominal Weight kg	Nominal Dimensions Diameter x Length mm
ZINC				
Z-6-12	2.7	305	7.7	127 x 510
Z-12-24	5.4	610	12.7	127 x 760
Z-24-48	10.9	1,220	24.5	127 x 1,520
MAGNESIUM				
M-9-14	4.0	340	13.0	160 x 430
M-17-20	7.7	640	22.0	160 x 760
M-32-22	14.5	560	40.0	210 x 760

TABLE 2
Anode Spacing for Over Pipe Method

Pipe Diameter mm	Anode Type	Spacing m
100	M-32-22	22.0
150	M-32-22	15.0
200	M-32-22	11.5
250	M-32-22	10.0
300	M-32-22	8.0
400	M-32-22	6.0
600	M-32-22	4.5

TABLE 3
Anodes Per Location for the Horizontal and Vertical Anode Bank Method

Pipe Diameter mm	Anode Type	Number of Anodes Per Location	Spacing m
150	M-32-22	8	70 ± 5
200	M-32-22	10	70 ± 5
250	M-32-22	12	70 ± 5
300	M-32-22	14	70 ± 5

TABLE 4
Anode Spacing for Metallic Pipe and Copper Services

Diameter mm	Anode Size	Maximum Spacing m
Less than 50 mm Copper Service	Z-12-24	20.0
50 mm Copper Service	Z-12-24	16.0
100	Z-24-48	12.0
150	Z-24-48	8.0
200	Z-24-48	6.0
250	Z-24-48	5.0
300	Z-24-48	4.0
400	Z-24-48	3.0

TABLE 5
Anode Locations and Spacing for New PVC Pipe with Metallic Components

Location	Anode Type	Maximum Spacing and Quantity
Less than 50 mm Copper Service	Z-12-24	20.0 m
50 mm Copper Service	Z-12-24	16.0 m
100 - 300 mm Metallic Fittings and Valves	Z-12-24	1 per fitting and valve
400 mm Metallic Fittings and Valves	Z-24-48	1 per fitting and valve
Hydrant Bases	Z-24-48	1 per hydrant
Tracer Wire	Z-12-24	1 per every 1,000 m of tracer wire

Appendix 442-A, November 2016 FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

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

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- The test station to be flush-mounted or post-mounted. (442.05.05)
- Length of post-mounted test stations (442.05.05)
- Type of C Taps. (442.05.07)
- Methods of corrosion protection. (442.07.04.06)
- Locations of concrete pressure pipe corrosion monitoring stations. (442.07.05)
- Splice connection method. (442.07.09)

Type and spacing of anodes are dependent on the soil conditions. Soil conditions should be verified before specifying the anode type and spacing. Assumptions used for anode spacings provided for new metallic watermain are as follows:

- i. Soil resistivity of 2,000 ohm-cm.
- ii. Bitumen coatings on pipe or other components are of no value (i.e., essentially bare).
- iii. 150 mm main with copper services should require about 2 mA of cathodic protection current per lineal foot and so in 2,000 ohm-cm soil 50 mA from a 24 lb zinc anode should cover 8.0 m of pipe.
- iv. 6.0 m spacing would allow for one anode per joint so discontinuities should not be a problem.
- v. A 24 pound zinc anode has a capacity of about 1,000 ma years so the anodes should have a life of about 20 years.

The anode items are titled "*type*" Individual Anode-Item and "*type*" Anode Bank-Item. The reference to "*type*" is to indicate that the complete item title for tender should include the type of anode (i.e., zinc or magnesium) required. (442.10.01)

The test station item is titled "*type*" Test Station-Item. The reference to type is to indicate that the complete item title for tender should include the type of test station (i.e., flush-mounted or post-mounted) required. (442.10.01)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 1109.010	Cathodic Protection for Metallic Watermain Systems
OPSD 1109.011	Cathodic Protection for PVC Watermain Systems
OPSD 1109.012	Cathodic Protection of Existing Metallic Watermains, Exposed Service or Pipe Method
OPSD 1109.013	Anode Installation Over Pipe Method for Existing Metallic Watermains
OPSD 1109.014	Vertical Anode Bank at Service

OPSD 1109.015 Horizontal Anode Bank at Service
OPSD 1109.025 Waterproofing of Splices



CONSTRUCTION SPECIFICATION FOR 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 municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

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

501.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

501.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 206	Grading
OPSS 401	Trenching, Backfilling, and Compacting
OPSS 506	Dust Suppressants

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 according to OPSS 506.

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.

The 2 methods for conducting QC for compaction are referred to as Method A and Method B. Method A shall be used when Method B is not specified in the Contract Documents.

Field density and field moisture determinations shall be made according to ASTM D 6938.

501.07.04.02 Method A

The Contractor is responsible for establishing QC procedures.

501.07.04.03 Method B

501.07.04.03.01 General

When Method B is specified in the Contract Documents, QC compaction testing shall be based on material placed and compacted in the Work on a lot-by-lot basis according to the Lot Testing clause. Compaction acceptance shall be according to the Acceptance clause and shall be based on target densities established according to the Target Density clause, QC compaction field test results, and, where applicable, a statistical analysis of those results.

501.07.04.03.02 Submission of Test Data

Prior to construction of a control strip, a copy of all QC laboratory test results for LS-706 required by the Control Strip clause to determine optimum moisture content (OMC) of the control strip material shall be delivered to the Contract Administrator.

All field test results and information relating to control strip, target density, lot location, lift thickness, probe depth, moisture content, and wet density shall be recorded at the time of testing. All of this data, as well as the QC lot compaction calculations, shall be submitted to the Contract Administrator within 2 Business Days following completion of a lot and prior to placement of any subsequent lift using the most recent version of MTO form PH-CC-009.

501.07.04.03.03 Test Equipment and Operator Training

501.07.04.03.03.01 General

Field density and field moisture measurements for QC compaction testing of earth and granular materials shall be carried out using gauges and ancillary equipment.

Only qualified operators using properly calibrated gauges shall conduct QC compaction testing.

501.07.04.03.03.02 Nuclear Moisture and Density Gauge Requirements

A copy of a valid calibration certificate, including the make, model number, and serial number for each gauge, shall be submitted to the Contract Administrator, prior to use of the gauge in compaction testing.

In addition, the Contract Administrator may request that the operator perform a standardization procedure according to ASTM D 6939.

If the gauge does not meet the standardization requirements or exhibits malfunctions of any kind, the gauge shall be replaced.

501.07.04.03.03.03 Operator Requirements

Each operator shall have been trained in the safe operation, transportation, and handling of the gauge.

Prior to conducting QC compaction testing, the operator shall provide acceptable proof of proficiency in the use of a gauge and the correct procedures to determine lot and 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.

501.07.04.03.04 Target Density

New target densities shall be established for each separate component of the Work (e.g., backfilling of a trench, construction of a granular base, or placement of cover) at the following times:

- a) For earth and granular materials:
 - i. At the time of initial use of each source.
 - ii. When there is a perceptible change in the appearance or gradation of 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.

501.07.04.03.04.01 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.

501.07.04.03.05 Lot Testing

For compaction control, a unique set of lots distinguished from each other by an appropriate letter or number designation, shall be established for each of the following:

- a) Each separate component of the Work (e.g., backfilling a structure or a trench or construction of a granular base).
- b) Materials from different sources.
- c) Materials with different compaction properties.
- d) When recompaction is carried out following restoration, scarification, or placement of additional material onto previously tested and accepted lots.
- e) When directed by the Contract Administrator.

The individual lots within each unique set of lots shall be consecutively numbered and with no duplication. Lot sizes shall not exceed the limits as shown in Table 1.

All visibly soft or loose areas shall be compacted prior to testing.

For the situations described in Table 1, Part IV, a minimum of 2 field density and moisture content tests shall be carried out at random locations within each lot.

For all other situations, each lot shall be divided into 4 equal sublots and a minimum of one field density and moisture test shall be carried out at random locations within each 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 nuclear 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.

For each test, the field wet density value and moisture content shall be immediately recorded on Form PH-CC-009. The dry field density of each subplot shall then be calculated as a percentage of the target density to the nearest 0.1%. The mean and the standard deviation and Quality Index, where applicable, of the field dry density values shall be calculated to the nearest 0.1% and recorded for each lot.

501.07.04.03.06 Quality Index

The Quality Index (Q_i), shall be calculated from the mean ($\bar{x}$) and standard deviation (s) of the percent target density which has been determined from all sublots within a QC compaction lot. 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:

$$s = \sqrt{\frac{\sum_{i=1}^4 (x_i - \bar{x})^2}{3}}$$

501.07.04.03.07 Acceptance

For the situations described in Table 1, Part IV, acceptance or rejection of a QC lot for compaction shall be based on 2 or more random field density and moisture content tests taken within the lot. For a lot to be acceptable, all tests shall be at least 100% and 98% of the target density established for granular and earth materials, respectively. Otherwise, the QC lot shall be rejected for compaction.

For all other situations, acceptance or rejection of a QC lot for compaction shall be established by calculation of the Quality Index, according to the Quality Index clause. When Q_i has a value equal to or greater than 1.47, the QC lot shall be accepted; otherwise, the lot shall be rejected for compaction.

Accepted QC lots damaged by vehicular traffic shall be restored prior to placement of any overlying material. Surfaces of accepted QC lots with ruts greater than 50 mm in depth in earth or 25 mm in depth in granular materials shall be regraded and the upper lift recompacted to meet the specified compaction requirements. Materials that cannot be successfully recompacted shall be removed and replaced with new material.

501.07.04.03.07.01 Rejected Lots

If a QC lot is rejected for compaction, the lot shall be recompacted with adjustment to the moisture content, as required, until satisfactory compaction is achieved. The recompacted lot shall be retested and a decision made, as described in the Acceptance clause.

When compaction of a QC lot does not meet the acceptance criteria and when the Contract Administrator has been satisfied that this is not a result of the Contractor's operation or equipment, a new target density shall be established for that operation.

501.07.05 Management of Excess Material

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

501.08 QUALITY ASSURANCE

501.08.01 General

Field density and field moisture determinations shall be made in accordance with ASTM D 6938.

When Method B is specified for the QC of compaction, then Method B shall be used for quality assurance (QA).

501.08.02 Method A

The MDD shall be determined using LS-706.

Granular materials shall be compacted to a density of 100% of the MDD and all earth materials shall be compacted to a density of 95% of the MDD.

The frequency and location of testing for QA shall be as determined by the Contract Administrator.

501.08.03 Method B

501.08.03.01 General

The Contract Administrator shall conduct random testing or inspection of QC records or both to establish the acceptability of the QC compaction testing and verification of the field moisture content, field dry density, OMC, MDD, target density, and the Quality Index, where applicable.

The Contract Administrator may verify that the target density established for a control strip is based on the use of suitable compaction equipment. Provided that the MDD and OMC values determined by LS-706, as applicable, indicate an adequate target density is being achieved, the compaction equipment shall be considered suitable. If the compaction equipment is not capable of obtaining an adequate target density at the required moisture content, the equipment shall be considered unsuitable and shall be replaced with equipment that is able to obtain an appropriate target density.

Reasonable access to a control strip or to compacted QC lots shall be provided prior to placement of subsequent lifts of material. Subsequent lifts, including HMA, may not be placed until QA testing has been conducted or waived by the Contract Administrator.

501.08.03.02 Gauge Verification

Gauge verification QA shall consist of taking 4 random field density and moisture content measurements of a compacted lot or control strip and the subsequent calculation of the average dry density. Provided that the average dry density determined by QC test results for the same material is within 139 kg/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.

501.08.03.03 Compaction

For the situations described in Table 1, Part IV, compaction QA shall consist of taking 2 or more random field density and moisture content measurements of each compacted lot and the subsequent determination of percent target density.

For all other situations, compaction QA shall consist of taking 4 random field density and moisture measurements of a compacted lot or control strip and the subsequent calculation of the Quality Index for the lot.

Provided that the lot is acceptable, according to the requirements specified in the Acceptance clause, no further action shall be taken.

However, if the lot is rejected based on compaction testing or demonstrates errors in QC reporting, an investigation shall take place to determine and resolve the discrepancies. The investigation may include, but is not limited to, any of the following:

- a) Recompaction of the lot.
- b) Retesting of the lot by the Contractor.
- c) Establishment of a new target density by control strip.
- d) Re-inspection of the gauge or operator or both by the Owner.
- e) Recalibration of the gauges.
- f) Removal of unsuitable materials.

501.08.03.04 Quality Control Records Inspections

QC records of the lot or control strip selected by the Contract Administrator shall be inspected for calculation errors, missing test data, or improper lot quantities. If errors or omissions are found that identify insufficiently compacted or improperly or untested lots, the Contractor shall make all such lots available and recompact or retest these lots or both so that they comply with the specified compaction requirements.

501.08.03.05 Charges

The Contract Administrator shall charge the Contractor \$450.00 for each lot that requires retesting which has been identified through QA compaction testing or a review of QC records. In addition, immediately following the discovery of a discrepancy or inadequate compaction, all new lots shall be subjected to QA compaction testing prior to acceptance. If any of the new lots do not meet the specified compaction requirements, the Contractor shall be charged a fee of \$450.00 for each lot. These conditions shall continue until 3 consecutive new lots have met the specified compaction requirements.

501.09 MEASUREMENT FOR PAYMENT

501.09.01 Actual Measurement

501.09.01.01 Water for Compaction

Measurement of water for compaction shall be in cubic metres using one of the following methods:

- a) The mass of the water shall be determined by weighing as specified in the Contract Documents. The mass of the water shall be converted to cubic metres using a factor of 1,000 kg to 1 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 using Method B shall be at no additional cost to the Owner.

Replacement of unsuitable equipment to obtain an appropriate target density using Method B shall be at no additional cost to the Owner.

Replacement of a gauge shall be at no additional cost to the Owner.

Any work required to recompact or retest material as a result of QA compaction testing or QC records inspection shall be at no additional cost to the Owner.

501.10.02**Water for Compaction - Item**

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

When the Contract does not contain a separate tender item for water for compaction, the Contract price for the tender item in which the water for compaction is used shall include full compensation for all labour, Equipment, and Material to do the work.

TABLE 1
Compaction Lot Size

Part	Construction	Lot Size
I	Earth embankments, granular base, granular subbase, and granular shoulders.	Every lift, 500 m maximum length. (Note 1)
II	Structure approach fill for earth.	Every lift, 50 m maximum length.
III	Bedding, embedment, cover, or backfill material for pipe and 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

The designer should determine if the following is required and, if so, specify it in the Contract Documents:

- Use of Method B. (501.07.04.01)

Method A is based on laboratory testing to determine optimum moisture content and maximum dry density and is generally used by municipalities.

Method B is a statistically based end result method that recognizes the variability of materials and testing and is generally used by the Ministry of Transportation of Ontario.

If the form in Appendix 501-B is to be used for submission purposes rather than the MTO form, it needs to be invoked by reference in the Contract Documents and a special provision should be written to delete the MTO form from the specification. (501.07.04.03.02)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

FOR USE IN MUNICIPAL CONTRACTS, WHEN REFERENCED IN THE CONTRACT DOCUMENTS

Note: This is a non-mandatory Additional Information Appendix intended to provide supplementary requirements for the OPS specification in a municipal contract, when the appendix is invoked by the Owner. It is written in mandatory language to permit invoking it by reference in the Contract Documents. If the appendix has not been invoked by reference in the Contract Documents, it does not apply.

FIELD COMPACTION REPORT

MATERIAL: _____

SOURCE: _____

GAUGE (make/model): _____

Serial No.: _____

CONTRACT NO.: _____

LOCATION: _____

QC ☐

QA ☐

Standard Readings		
Calibration	Reference	Difference (%)
Density		
Moisture		

Target Density	
Control Strip, t/m ³	
Proctor, %	
MDD, t/m ³	
OMC, %	

(± 2.0% max)
(± 4.0% max)

Quality Index, Q_i	
For embankments within 50 m of a structure; bedding, embedment, cover, or backfill material to pipes, sewers, or culverts; or backfill to structures, utility structures, or small foundations (e.g., anchor blocks, sign posts; and formwork):	
Earth: $Q_i = \frac{\bar{x}-95}{s}$	Granular: $Q_i = \frac{\bar{x}-98}{s}$
For materials placed in all other situations:	
Earth: $Q_i = \frac{\bar{x}-90}{s}$	Granular: $Q_i = \frac{\bar{x}-95}{s}$

Lot	Sublot	Location						Lift cm	Probe Depth cm	Moisture Content %	Density			Relative Compaction				Accepted (A) Rejected (X) Retest (R)
		Grade	Structure	Foundation	Pipe	Sewer	Culvert	Other	Station	Offset	Count/ minute	Wet Density, tonnes/m ³	Dry Density, tonnes/m ³	% Target Density	Lot Mean - x	Lot Standard Deviation s	Quality Index Q_i	
	1																	
	2																	
	3																	
	4																	
	1																	
	2																	
	3																	
	4																	
	1																	
	2																	
	3																	
	4																	

NOTES: a) Where $Q_i \geq 1.47$, then 99% of the lot will have compaction above the specified limits, otherwise, the lot is rejected and shall be recompacted and retested.
b) Retested areas should be indicated with "R" using the original lot number.

REMARKS:

TECHNICIAN: _____

PRINT NAME _____

SIGNATURE _____

DATE _____

Copies to: Contract Administrator ☐ Contractor ☐



CONSTRUCTION SPECIFICATION FOR REMOVAL

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510-A	Commentary

510.01 SCOPE

This specification covers the requirements for demolition, salvage, removal, and in-place abandonment, either completely or partially, of those materials and structures so designated, including the requirements for backfilling resulting excavations, trenches, holes, and pits.

510.01.01 Specification Significance and Use

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

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

510.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

510.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 301	Restoring Unpaved Roadway Surfaces
OPSS 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 mean as defined in OPSS 410, 421, and 422.

Culvert means a single or multiple cell structure designed to provide an opening under a roadway, pedestrian way, railway, or side entrance for the passage of surface water, livestock, or pedestrians.

Curb and Gutter means any combination of curb, gutter, curb with gutter, gutter setbacks, bullnoses, gutter outlets, and spillways.

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

HIR means hot in-place recycling.

Pipe means any closed conduit originally designed to convey liquid or gas.

Sundry Asphalt Pavements means paved islands, medians, boulevards, and walkways.

510.04

DESIGN AND SUBMISSION REQUIREMENTS

510.04.01

Design Requirements

Caps for capping maintenance holes, catch basins, ditch inlets, and valve chambers shall be designed according to CAN/CSA S6 and the Structural Manual.

510.04.02

Submission Requirements

510.04.02.01

Removal of Bridge Structures

Two weeks prior to commencement of the work, a work plan shall be submitted to the Contract Administrator outlining the equipment to be used, dust and debris control, and the sequence of removals for bridge demolition.

Where any portion of the bridge structure is to support traffic or equipment loading during demolition, the entire structure shall be evaluated for load carrying capacity according to the CAN/CSA S6 and the Structural Manual.

All submissions shall bear the seal and signature of the design Engineer and design check Engineer.

510.05 MATERIALS

510.05.01 Mortar

Mortar shall consist of a mixture of one part Portland cement according to OPSS 1301 and three parts mortar sand according to OPSS 1004, wetted with sufficient water to make the mixture plastic. Water shall be according to OPSS 1302.

510.05.02 Concrete

Concrete for concrete seals shall be according to OPSS 1350 with minimum specified 28-Day compressive strength of 30 MPa.

Concrete for filling abandoned pipes shall be according to OPSS 1350 with minimum specified 28-Day compressive strength of 15 MPa.

510.05.03 Grout

Grout shall consist of a mixture of one part Portland cement according to OPSS 1301 and two parts mortar sand according to OPSS 1004, wetted with sufficient water to make the mixture plastic. Water shall be according to OPSS 1302.

510.07 CONSTRUCTION

510.07.01 General

Removal, abandonment, demolition, or salvage of a particular item shall be as specified in the Contract Documents.

The work shall include all associated excavation, backfill, compaction, trimming, plugging, capping, filling, sealing, and right-of-way preparation.

If provided, existing drawings from the Owner pertaining to bridge structures, modular bridges, culverts, and noise barriers designated for removal shall be reviewed prior to commencement of any activities.

Stockpiling requirements shall be as specified in the Contract Documents.

Where work is done in waterbodies and on waterbody banks, the work shall be according to the Contract Documents.

510.07.01.01 Excavation

Excavation required for the removal work to be carried out shall be part of the removal operation and shall be performed in such a manner as to leave undisturbed any portions not designated for removal.

510.07.01.02 Removal

Removal shall be performed in such a manner and with such equipment as to leave undisturbed and undamaged any portion not designated for removal or salvage. All damaged or disturbed portions shall be corrected expeditiously and repaired to the satisfaction of the Contract Administrator. The broken edges of portions to be left in place that are visible after construction shall be squared and neatly trimmed.

510.07.01.03 Salvage

Any material designated for salvage shall remain the property of the Owner and shall be maintained in a reasonable condition and stockpiled in a manner acceptable to the Contract Administrator.

Salvaged materials that are surplus to the Contract requirements shall be delivered to the location specified in the Contract Documents. When designated for salvage and surplus to the Contract requirements, salvaged frames and related grates or covers shall be kept together as a unit for delivery and stockpiling.

Any material designated for salvage damaged by the Contractor's operations or lost by the Contractor at any time prior to re-use or stockpiling shall be replaced with new material.

510.07.01.04 Backfilling, Compacting, and Trimming

Where a removal or partial removal requires the filling of a resulting trench, hole, or pit, backfilling shall be to the required grade using either suitable excavated material or imported material as required or as specified in the Contract Documents, and shall include levelling and trimming of the site to match required contours and provide adequate drainage. Backfill material shall be placed 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 1200 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.

Where 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.

Before 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.

Temporary transverse ramping shall be as specified in the Contract Documents. If due to unforeseen circumstances, removal cannot be done full width prior to shut down at the end of the day, then temporary, longitudinal ramping shall also be provided as specified in the Contract Documents. All ramping shall be removed prior to placing adjacent hot mix asphalt pavement.

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.

510.07.06.05 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
Removal of Concrete Curb and Gutter - Item
Removal of Maintenance Holes, Catch Basins, Ditch Inlets, and Valve Chambers - Item
Abandonment of Maintenance Holes, Catch Basins, Ditch Inlets, and Valve Chambers Partial-Depth - Item
Capping of Maintenance Holes, Catch Basins, Ditch Inlets, and Valve Chambers - Item
Removal of Pipe and Culverts - Item
Abandonment of Pipes and Culverts - Item
Removal of Pipe Subdrains - Item
Removal of Hydrants - Item
Removal of Valves - Item
Removal of Watermain Appurtenances - Item
Removal of Fence - Item
Removal of Noise Barriers - Item**

Removal of Delineator Posts - Item
Removal of Cable Guide Rail - Item
Removal of Concrete Barrier - Item
Removal of Steel Beam Guide Rail - Item
Removal of Steel Box Beam Barrier - Item
Removal of Anchor Blocks - Item
Removal of Energy Attenuators - Item
Removal of Ramp Closure Gates - Item
Cutting Existing Pavement - Item
Removal of Asphalt Pavement - Item
Removal of Asphalt Pavement from Concrete Surfaces - Item
Removal of Concrete Pavement - Item
Removal of Asphalt-Treated Base - Item
Removal of Cement-Treated Base - Item
Removal of Concrete Base - Item
Removal of Asphalt Pavement, Partial-Depth - Item
Removal of Asphalt Pavement from Concrete Surfaces on Structures - Item
Removal of Concrete Pavement, Partial-Depth
Removal of Concrete - Item
Preparing Right-of-Way - Item
Removal of Driveways, Sidewalks, and Sundry Asphalt Pavements - Item
Removal of Concrete Sidewalk - Item
Removal of Gabions - Item
Removal of Sign Support Structure - Item
Removal of Sign Support Structure Footings - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Imported backfill shall be paid for separately according to the tender item of the material specified in the Contract Documents.

Payment at the Contract price for the appropriate removal tender item shall be full compensation for all labour and Equipment for earth excavation required in the course of the removal operations.

Material designated for salvage but damaged by Contractor operations or lost by the Contractor shall be replaced with new material at no additional cost to the Owner.

If the Contractor elects to remove maintenance holes, catch basins, ditch inlets, and valve chambers in their entirety rather than as a partial removal, the removal shall be at no additional cost to the Owner.

When the Contract does not contain a separate item for the removal of pipe subdrain, 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 watermain, 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

The designer should specify the following in the Contract Documents:

- Items that are to be removed, abandoned, demolished, or salvaged. (510.07.01)
- Stockpiling requirements. (510.07.01)
- Requirements for work that is to be carried out in waterbodies or on waterbody banks. (510.07.01)
- For removal items,
 - Delivery locations for salvaged materials in excess to Contract requirements (510.07.01.03)
 - For bridge structures, specify the line and grade to which the structure is to be removed. (510.07.02.01)
 - Destination of modular bridge components. (510.07.02.02)
 - Approximate weight of the modular bridge to be removed. (510.07.02.02)
 - Management of modular bridge substructure materials. (510.07.02.02.01)
 - Delivery requirements for ramp closure gates. (510.07.05.05)
 - Temporary ramping requirements. (510.07.06.01)
 - For pavement, specify the depth of sawcut and identify the pavement type; thickness; size of reinforcement, if any; and management of materials. (510.07.06.02 and 510.07.06.03)
 - For partial-depth pavement, identify the average depth of the removal and management of materials. (510.07.06.05)
- Method of measurement for the partial-depth removal of asphalt or concrete pavement. (510.09.01.18)

The designer should determine if the following is required and, if so, specify it in the Contract Documents:

- Imported backfill. (510.07.01.04)

The designer should list in the Contract Documents existing drawings available, if any, for structures to be removed. (510.07.01)

The designer should determine if special restrictions or permits apply where work under the specification is required in waterbodies or on waterbody banks.

For the demolition of bridges, OPSS 510 does not place any restrictions on the Contractor in terms of methods or equipment to be used. Therefore, when it is foreseen that a demolition will require special requirements or safety precautions, the designer should include these requirements in the Contract Documents.

The designer should determine which removals are included under Earth Excavation and Grading. (510.10.03)

The designer should ensure that the removal of asphalt from bridge decks is to be paid separately, when the entire bridge deck is removed and the asphalt cannot be mixed with concrete.

The designer should ensure that all items to be left in place are in accordance with environmental constraints and requirements.

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Removed items may contain materials that may be subject to specific handling and disposal requirements (e.g., asbestos and slag). The designer should ensure that these requirements are included where such materials are known to exist.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 102.010	Removals, Legend
OPSD 710.010	Capping Existing Structures, Maximum 4.0 m Cover



CONSTRUCTION SPECIFICATION FOR INSTALLATION OF GABIONS

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512-A	Commentary

512.01 SCOPE

This specification covers the requirements for the installation of gabions.

512.01.01 Specification Significance and Use

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

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

512.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 206	Grading
OPSS 490	Site Preparation for Pipelines, Utilities, and Associated Structures
OPSS 501	Compacting
OPSS 517	Dewatering of Pipeline, Utility, and Associated Structure Excavation
OPSS 805	Temporary Erosion and Sediment Control Measures

Ontario Provincial Standard Specifications, Material

OPSS 1004	Aggregates - Miscellaneous
OPSS 1430	Gabion Baskets and Mats
OPSS 1860	Geotextiles

512.03 DEFINITIONS

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

Gabion means a gabion basket or a gabion mat filled with gabion stones.

512.05 MATERIALS

512.05.01 Gabion Baskets and Gabion Mats

Gabion baskets and gabion mats shall be according to OPSS 1430.

Gabion baskets shall be manufactured from galvanized steel wire mesh or PVC coated galvanized steel wire mesh as specified in the Contract Documents. When the type of mesh is not specified in the Contract Documents, the gabion baskets shall be manufactured from PVC coated galvanized steel wire mesh.

Gabion mats shall be manufactured from PVC coated galvanized steel wire mesh.

512.05.02 Gabion Stones

Gabion stones shall be according to OPSS 1004 and as specified in the Contract Documents.

512.05.03 Geotextile

Geotextile shall be non-woven, Class II according to OPSS 1860, with an FOS of 75-150 µm, unless otherwise specified in the Contract Documents.

512.07 CONSTRUCTION

512.07.01 Site Preparation

Site preparation shall be according to OPSS 490.

512.07.02 Dewatering

Dewatering shall be according to OPSS 517.

512.07.03 Temporary Erosion and Sediment Control Measures

Temporary erosion and sediment control measures according to OPSS 805 shall be implemented when gabions are placed in or along a watercourse.

512.07.04 Excavation, Bedding, and Backfill

Excavation for gabions shall be according to OPSS 206.

Corrective measures ordered by the Contract Administrator to rectify deficiencies caused by over-excavation shall be performed. Material placed in the over-excavated area shall be compacted to the density requirements of OPSS 501.

Bedding and backfill shall be as specified in the Contract Documents.

512.07.05 Assembly of Gabions

Gabions shall be installed at the locations and to the line, grade, and dimensions specified in the Contract Documents.

Gabions shall be assembled 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 Management of Excess Material

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

512.09 MEASUREMENT FOR PAYMENT

512.09.01 Actual Measurement

512.09.01.01 Gabions

Measurement of gabions shall be by volume in cubic metres based on the nominal dimensions of the gabions used. When the gabion excavation overlaps excavation required for other work, the measurement shall be made as specified with no deduction for overlaps.

512.09.01.02 Geotextile

Measurement of geotextile shall be by area in square metres, in place, without any allowance made for overlaps.

512.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

512.10 BASIS OF PAYMENT

**512.10.01 Gabions - Item
Geotextile - Item**

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Any costs associated with any unauthorized over-excavation shall be the Contractor's responsibility and at no additional cost to the Owner.

Appendix 512-A, November 2014 FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

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

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Gradation requirements of gabion stone as per Table 8 of OPSS 1004. (512.05.02)
- Use of alternate geotextile requirements for site or project specific applications. (512.05.03)
- Bedding and backfill requirements. (512.07.04)
- Location, line, grade, and dimensions of gabions. (512.07.05)
- Additional assembly requirements. (512.07.07)
- Placement requirements for geotextile. (512.07.08)

The designer should determine which type of mesh is to be used for the gabion baskets and specify it in the Contract Documents. PVC coated gabion baskets are recommended in aggressive environment when road salt may be present and in aquatic and marine applications. (512.05.01)

For extremely fine grained soil, geotextile with an FOS of 50-100 µm should be specified. (512.05.03)

The designer should determine if the exposed wall surfaces require a uniform appearance. (512.07.05)

The designer should determine if gabion height limits are necessary, and if required, they should be specified in the Contract Documents.

When a gabion installation performs a retaining function (i.e., headwall, wingwall, retaining wall, or toe wall) and holds up an embankment, the designer should consult an Engineer.

The designer should review the expected design life of the gabion installation prior to specifying the product.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.



**ONTARIO
PROVINCIAL
STANDARD
SPECIFICATION**

**METRIC
OPSS.MUNI 517
NOVEMBER 2016**

(Formerly OPSS 517 November 2010)

Note: The MUNI implemented in November 2016 replaces OPSS 517 COMMON, November 2016 with no content changes.

**CONSTRUCTION SPECIFICATION FOR
DEWATERING OF PIPELINE, UTILITY, AND
ASSOCIATED STRUCTURE EXCAVATION**

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517-A	Commentary

517.01 SCOPE

This specification covers the requirements for dewatering procedures to stabilize the ground and keep excavations free of water during installation of sanitary and storm pipe sewers, pipe culverts and end sections, forcemains and associated appurtenances, watermains and associated appurtenances, and other underground Utilities; maintenance holes, catch basins, ditch inlets, and valve chambers; and any other specified subsurface construction.

517.01.01 Specification Significance and Use

This specification has been developed for use in provincial and municipal-oriented Contracts. The administration, testing, and payment policies, procedures, and practices reflected in this specification correspond to those used by many municipalities and the Ontario Ministry of Transportation.

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

517.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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.

517.02 REFERENCES

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

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 412	Sewage Forcemain Installation in Open Cut
OPSS 441	Watermain Installation in Open Cut
OPSS 518	Control of Water From Dewatering Operations

517.03 DEFINITIONS

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

Associated Appurtenances mean as defined in OPSS 412 and OPSS 441.

Surrounding Area means as specified by the Ministry of the Environment (MOE) or as specified in the Contract Documents.

517.04 DESIGN AND SUBMISSION REQUIREMENTS

517.04.01 Submission Requirements

The following information shall be submitted to the Contract Administrator for review at least two weeks prior to the commencement of dewatering operation:

- a) Unless provided in the Contract Documents, the permit issued by MOE for taking water from a ground water source, if required.
- b) Monitoring and contingency plans that address potential impacts to items such as, but not limited to, settlement, ground water usage and electrical and mechanical equipment failures.
- c) Stand-by power or pumping capacity or both, if required by the Contract Documents.
- d) Calibration documentation for the flow metering system.

517.07 CONSTRUCTION

517.07.01 Dewatering

A continuous dewatering operation shall be provided to keep the excavation stable and free of water. The excavation shall be monitored to ensure it remains stable and free of water.

The dewatering system shall be maintained and the surrounding area monitored for impacts to items such as, but not limited to, settlement and ground water usage. Any impacts shall be immediately reported to the Contract Administrator.

When a stand-by power or pumping system or both are required, they shall be as specified in the Contract Documents, and shall be installed on-site.

The availability, location, and use of automatic transfer switching shall be as specified in the Contract Documents.

Dewatering shall be discontinued in a manner so that disturbance of any structure or pipeline is avoided.

517.07.02 Control of Water

The control of water shall be according to OPSS 518.

517.07.03 Management of Excess Material

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

517.10 BASIS OF PAYMENT

Payment at the Contract price for the appropriate tender items for the installation of sanitary and storm pipe sewers, pipe culverts and end sections, forcemains and associated appurtenances, watermain and associated appurtenances, and other underground Utilities; maintenance holes, catch basins, ditch inlets, or valve chambers; and any other specified subsurface construction shall be full compensation for all labour, Equipment, and Material to do the work.

Appendix 517-A, November 2010
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

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

Designer Action/Considerations

The designer may consider including soil boring data, a geotechnical report, a subsurface report, or a soils report in the Tender Documents.

The designer should specify the following in the Contract Documents:

- Surrounding area. (517.03)
- Stand-by power or pumping capacity or both. (517.04.01)
- When required, stand-by power or pumping system or both. (517.07.01)
- Availability, location, and use of automatic transfer switching, based on site conditions, impacts, and risk assessment. (517.07.01)

Due to the time required, the designer should consider obtaining the dewatering permit to avoid delays. (517.04)

The need for a specific dewatering scheme should be determined. If a specific dewatering scheme is necessary, it should be specified in the Contract Documents.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR CONTROL OF WATER FROM DEWATERING OPERATIONS

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518.08	QUALITY ASSURANCE - Not Used
518.09	MEASUREMENT FOR PAYMENT - Not Used
518.10	BASIS OF PAYMENT

APPENDICES

518-A	Commentary

518.01 SCOPE

This specification covers the requirements for the control of water from dewatering operations prior to discharge to the environment and sewer systems. This specification does not apply to the management of contaminated water.

518.01.01 Specification Significance and Use

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

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

518.01.02 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.

518.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 805 Temporary Erosion and Sediment Control Measures

518.03 DEFINITIONS

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

Dewatering Operation means pumping, baling, temporary ditching, or vacuum removal of uncontaminated groundwater, rain water, melt water, stormwater, surface run-off, water pipe leakage from excavations and trenches or within sheeted cofferdams to improve the soil stability or for other construction purposes.

Vegetated Discharge Area means a sloped, open area of land with existing vegetation suitable to prevent erosion.

Sediment means soil particles detached from an earth surface by erosion.

Sediment Control Measure means a measure to remove sediment from water prior to discharge to the environment and sewer systems.

518.07 CONSTRUCTION

518.07.01 Discharge of Water

Water from dewatering operations shall be directed to a sediment control measure and/or a vegetated discharge area according to OPSS 805 prior to discharge to the environment.

When water is discharged from a sediment control measure or a vegetated discharge area to the environment, it shall be done in a manner that does not cause erosion or other damage to adjacent lands.

Owner approval shall be obtained prior to discharge of water to a sewer system.

All other required approvals for dewatering operations shall be obtained and/or complied with prior to and during discharge of water.

518.07.02 Discharge to Sediment Control Measures

The installation, maintenance, and removal of temporary erosion and sediment control measures shall be according to OPSS 805 and as specified in the Contract Documents.

518.07.03 Discharge to Vegetated Discharge Areas

Equipment and materials not related to dewatering shall not be used or stored in vegetated discharge areas.

518.07.04 Discharge to the Environment

The discharge of water to the natural environment shall not be directed across pavements, sidewalks, curb and gutter or similar hard surfaces except through appurtenances as specified in the Contract Documents.

518.07.05 Management of Excess Material

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

518.07.06 Protection of Waterbodies and Waterbody Banks

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

518.10 BASIS OF PAYMENT

Payment at the Contract price for the appropriate tender items associated with dewatering 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 518-A, November 2016 FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

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

Designer Action/Considerations

The designer should be aware that this specification does not apply to contaminated water sources.

The designer should specify the following in the Contract Documents:

- Construction requirements for sediment control measures. (518.07.02)
- Types of erosion and sediment control measures. (518.07.03)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 219.100 Light-Duty Straw Bale Barrier
OPSD 219.110 Light-Duty Silt Fence Barrier
OPSD 219.120 Light-Duty Fibre Roll Barrier
OPSD 219.130 Heavy-Duty Silt Fence Barrier
OPSD 219.131 Heavy-Duty Wire-Backed Silt Fence Barrier
OPSD 219.150 Sandbag Barrier
OPSD 219.160 Fibre Roll Grade Breaks
OPSD 219.180 Straw Bale Flow Check Dam
OPSD 219.191 Fibre Roll Flow Check Dam
OPSD 219.200 Sandbag Flow Check Dam
OPSD 219.210 Temporary Rock Flow Check Dam V-Ditch
OPSD 219.211 Temporary Rock Flow Check Dam Flat Bottom Ditch
OPSD 219.220 Sediment Trap In Ditch
OPSD 219.230 Temporary Slope Drain For Sediment Trap
OPSD 219.231 Temporary Berm Barrier
OPSD 219.240 Sediment Trap for Dewatering
OPSD 219.260 Turbidity Curtain
OPSD 219.261 Turbidity Curtain Seam Detail



CONSTRUCTION SPECIFICATION FOR TEMPORARY PROTECTION SYSTEMS

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539-A	Commentary
539-B	Supplemental Requirements for Using OPSS 539 in Municipal Contracts

539.01 SCOPE

This specification covers the requirements for the design, construction, maintenance, monitoring, and removal of a temporary protection system made necessary by excavation, embankment construction, dewatering, or other work.

539.01.01 Specification Significance and Use

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

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

539.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

539.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 903	Deep Foundations
OPSS 904	Concrete Structures
OPSS 906	Structural Steel for Bridges
OPSS 942	Prestressed Soil and Rock Anchors

Ontario Provincial Standard Specifications, Material

OPSS 1350	Concrete - Materials and Production
OPSS 1601	Wood Material, Preservative Treatment, and Shop Fabrication

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.

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

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 subsection 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 shall be removed from the right-of-way, unless it is specified in the Contract Documents that the protection system may be left in place.

Where piles 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.

The method and sequence of removal shall be such 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

The designer should specify the following in the Contract Documents:

- Protection system performance level. (539.04.01.01)
- Location of excavations requiring protection systems. (539.04.01.01)
- When another authority is affected by the Contractor's operation. (539.04.02.01)

OPSS 539 contains information written for provincial Contracts. To ensure completeness of municipal Contract Documents, the designer should invoke Appendix 539-B. The appendix contains supplemental requirements that modify OPSS 539 so it can be used by a municipality in its Contracts.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

Appendix 539-B, November 2014

FOR USE IN MUNICIPAL CONTRACTS, WHEN REFERENCED IN THE CONTRACT DOCUMENTS

Note: This is a non-mandatory Additional Information Appendix intended to provide supplementary requirements for the OPS specification in a municipal contract, when the appendix is invoked by the Owner. It is written in mandatory language to permit invoking it by reference in the Contract Documents. If the appendix has not been invoked by reference in the Contract Documents, it does not apply.

Supplemental Requirements for Using OPSS 539 in Municipal Contracts

OPSS 539, Protection Systems, is amended as follows:

539.03 DEFINITIONS

Section 539.03 is amended by the deletion of the definitions for Certificate of Conformance and for Quality Verification Engineer.

Section 539.03 is amended by the addition of the following:

Certificate of Installation means a document issued by the design Engineer or design-checking Engineer confirming that the specified components of the Work are in general conformance with the requirements as specified in the Contract Documents.

539.04.02.01 Working Drawings

The first paragraph of clause 539.04.02.01 is deleted in its entirety and replaced by the following:

The Contractor shall submit 5 sets of Working Drawings to the Contract Administrator at least 3 weeks prior to commencement of the protection system 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.

539.04.02.01 Working Drawings

Clause 539.04.02.01 is amended by the addition of the following:

539.04.02.01.01 Return of Submissions

Two copies of each submission shall be returned as one of the following:

- a) Stamped with the wording that allows for permission to construct. In this case, work can commence on receipt of the drawings by the Contractor.
- b) Stamped with the wording that allows for permission to construct as noted. In this case, work can start on receipt of the drawings by the Contractor. The drawings shall be updated as noted and shall be sealed and signed by the design Engineer and the design-checking Engineer stating the drawings have been revised according to the noted comments.
- c) Showing only required changes. In this case, the drawings shall be updated, as required, and the submission process repeated.

The Contractor shall have a copy of the stamped updated or accepted drawings at the site prior to the commencement of the protection system installation.

Appendix 539-B

539.04.02.05.01 Excavation Depths Less Than or Equal to Three Metres

The first sentence of clause 539.04.02.05.01 is deleted in its entirety and replaced by the following:

The design Engineer or the design-checking Engineer shall witness interim inspections of the following work:

539.04.02.05.02 Excavation Depths Exceeding Three Metres

The first sentence of clause 539.04.02.05.02 is deleted in its entirety and replaced by the following:

The design Engineer or the design-checking Engineer shall witness interim inspections of the following work:

539.07.01 General

The first paragraph of subsection 539.07.01 is deleted in its entirety and replaced by the following:

The Contractor shall be responsible for the design, materials, construction, maintenance, monitoring, and removal of a temporary protection system except for Owner designed systems, in which case, the design and monitoring shall be by the Owner.

539.07.03.04 Certificates of Conformance

Clause 539.07.03.04 is deleted in its entirety and replaced by the following:

539.07.03.04 Certificate of Installation

539.07.03.04.01 Excavation Depths Less Than or Equal to Three Metres

For Contractor designed 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 installation shall be submitted to the Contract Administrator upon completion of the operation of the protection system and removal of the protection system. The design Engineer or design-checking Engineer's seal and signature shall be affixed on the completed certificate of installation 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 installation requirements as specified in the Excavation Depths Exceeding Three Metres clause shall apply.

Appendix 539-B

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 installation shall be submitted to the Contract Administrator upon completion of the operation of the protection system and removal of the protection system. The design Engineer or design-checking Engineer's seal and signature shall be affixed on the completed certificate of installation 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.



CONSTRUCTION SPECIFICATION FOR REMOVAL OF ELECTRICAL EQUIPMENT AND MATERIALS

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610-A	Commentary

610.01 SCOPE

This specification covers the requirements for demolition, salvage, and removal, either completely or partially, of electrical equipment and materials.

610.01.01 Specification Significance and Use

This specification has been developed for use in provincial- and municipal-oriented Contracts. The administration, testing, and payment policies, procedures, and practices reflected in this specification correspond to those used by many municipalities and the Ontario Ministry of Transportation.

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

610.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

610.02 REFERENCES

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

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 492	Site Restoration Following Installation of Pipes, Utilities, and Associated Structures
OPSS 510	Removal

610.04 DESIGN AND SUBMISSION REQUIREMENTS

610.04.01 Submission Requirements

610.04.01.01 Operations Plans

An operations plan shall be submitted to the Contract Administrator a minimum of 3 weeks prior to the commencement of polychlorinated biphenyl (PCB) related activities. The plan shall describe the overall approach to the work and include the following:

- a) Operational methodologies.
- b) Work area delineation and security details.
- c) Environmental impact management, such as spill prevention and containment and emergency response plan.
- d) Contamination control.
- e) Equipment and area decontamination procedures.
- f) Ontario Ministry of the Environment (MOE) Environment Compliance Approval numbers as applicable for transportation and transfer facilities.

PCB wastes and PCB related wastes to be moved to a transfer facility shall be included in the operations plan with details regarding their eventual transport to a disposal facility for destruction.

610.07 CONSTRUCTION

610.07.01 General

General requirements for electrical work shall be as specified in the Contract Documents.

Demolition, salvage, and removal of electrical equipment and materials shall be as specified in the Contract Documents.

The Contractor shall acquire all permits, approvals, releases, and agreements necessary to do the work.

610.07.02 Timing of Work

Existing electrical systems required to continue in-service shall remain functional during construction operations until new or modified systems are operational.

610.07.03 Removal

Removal of non-electrical material and objects required for the removal of electrical equipment and material shall be according to OPSS 510.

Electrical concrete structures shall be removed to a minimum of 1.0 m below finished grade.

Where partial removal of pavement, sidewalk, curb and gutter, or other structures is required for removal of electrical equipment, the broken edges of the object to remain in place shall be squared up and trimmed along straight lines at a minimum distance of 300 mm from any area disturbed by removal operations.

Steel reinforcement, conduits, ducts, wires, and debris associated with the removed portions of such structures shall be removed for disposal.

610.07.04 Demolition

Demolition of concrete, brick, timber, and masonry structures, including pole footings, equipment pads, concrete poles, and substation buildings shall be carried out in such a manner and with such equipment as not to disturb adjacent pavement, Utilities, other works, or electrical equipment and material to remain in place and with such care as to leave material designated to be salvaged in an undamaged condition.

610.07.05 Luminaires

Prior to removing luminaires, all lamps and glass shall be removed.

610.07.06 Cables and Conduits

Underground cables shall be completely removed and conduit systems shall be cut back to a depth of 600 mm below finished grade and abandoned in place.

610.07.07 Transformers

Transformers containing PCBs, including all internal components, and all PCB related wastes shall be removed and managed as subject waste as specified in the Contract Documents.

Transformers not containing PCBs shall be removed, salvaged, and transported to storage sites specified in the Contract Documents.

610.07.08 Temporary Installations

Equipment and materials supplied by the Contractor for use with temporary installations shall be removed. Equipment and materials supplied by the Owner for use with temporary installations shall be removed and salvaged as specified in the Contract Documents.

610.07.09 Salvage of Equipment

610.07.09.01 Damages

Due care shall be exercised when removing electrical equipment and materials for salvage. Equipment and materials damaged through improper handling or through loss after removal shall be repaired or replaced.

Prior to removal operations, the Contract Administrator shall be notified of any equipment that is broken or deteriorated to the point where salvage is not practical.

610.07.09.02 Packaging of Electrical Equipment and Materials

Electrical equipment and materials that has been removed shall be packed for protection against damage.

All equipment or material in excess of 100 kg shall be securely mounted on wooden pallets suitable for handling by forklift trucks.

610.07.09.03 Shipping of Salvaged Electrical Equipment and Materials

All salvaged equipment and materials shall be loaded, transported, and unloaded at the sites specified in the Contract Documents.

Delivery to any Owner unloading sites shall be made between 09:00 and 15:30, local time. The Contract Administrator shall be notified 3 Business Days in advance of delivery to the Owner's unloading sites.

610.07.10 Quality Control

610.07.10.01 Pre-Removal Testing and Inspection

Components specified for removal shall be inspected prior to removal. If the components are to be salvaged for reuse within the Contract limits or for storage at the Owner's premises, the Contractor shall make a list of any imperfections of those components and shall submit the list to the Contract Administrator 3 Business Days prior to the commencement of removal.

610.07.10.02 Proof of Performance Testing and Inspection

The removal work shall be inspected to ensure that all electrical removals have been carried out and that all components requiring disposal at approved sites have been completed so that no such materials remain on the Owner's lands.

610.07.11 Site Restoration

Site restoration shall be according to OPSS 492.

610.07.12 Management of Excess Material

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

610.10 BASIS OF PAYMENT

610.10.01 Removal of Electrical Equipment - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Materials to do the work.

Work required to salvage and transport liquid type transformers shall be paid as Extra Work.

Appendix 610-A, November 2016
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

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

Designer Action/Considerations

The design should specify the following in the Contract Documents:

- Electrical equipment and materials for demolition, salvage, and removal. (610.07.01)
- Subject waste management requirements. (610.07.07)
- Storage sites for transformers without PCBs. (610.07.07)
- Salvage requirements for equipment and material removed from temporary installations. (610.07.08)
- Salvaged equipment and material unloading sites. (610.07.09.03)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.



**CONSTRUCTION SPECIFICATION FOR
INSTALLATION OF SECTIONAL STEEL
HIGH MAST LIGHTING POLES**

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APPENDICES

630-A	Commentary

630.01 SCOPE

This specification covers the requirements for the installation of sectional steel high mast lighting poles complete with raising and lowering equipment, including mechanical and electrical components.

630.01.01 Specification Significance and Use

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

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

630.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

630.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Material

OPSS 2471	Sectional Steel High Mast Lighting Poles
OPSS 2476	Raising and Lowering Equipment for High Mast Lighting Poles

CSA Standards

S6-14	Canadian Highway Bridge Design Code

630.03 DEFINITIONS

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

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

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

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

630.04 DESIGN AND SUBMISSION REQUIREMENTS

630.04.01 Submission Requirements

630.04.01.01 Assembly of Sectional Steel High Mast Lighting Poles

The Contractor shall submit installation drawings, calculations, and procedures to the Contract Administrator at least 14 Days prior to the commencement of scheduled start of pole assembly for approval. An Engineer shall affix his or her seal and signature on the installation drawings, calculations, and procedures verifying that they are consistent with the Contract Documents and sound engineering practices.

These installation drawings, calculations, and procedures shall include all details of equipment to be used in jacking the sections together and lifting the assembled pole, including placing and securing it on the anchorage assembly.

630.04.01.02 Training Certificate

A certificate of training from the manufacturer of the high mast lighting raising and lowering equipment for each person who will be doing the installation work shall be submitted to the Contract Administrator. The certificates shall be submitted 14 Days prior to the commencement of the installation work, and the work shall not proceed until the certificates are accepted by the Contract Administrator. Training certificates that are 5 years old or more shall not be accepted.

The training certificate shall state that the manufacturer certifies that the individual has successfully completed an in-depth training course in the following areas:

- a) Assembly of the pole sections.
- b) Assembly of the raising and lowering equipment.
- c) Operation of the raising and lowering equipment.
- d) Installation of high mast poles and lighting equipment.
- e) Levelling of the luminaire ring assembly.
- f) Inspection of high mast poles and lighting equipment.
- g) Maintenance and repair techniques for sectional steel high mast lighting equipment.
- h) Safety procedures.

The training certificate shall be dated and signed by officers of the manufacturer and shall indicate the dates that the training was given.

630.05 MATERIALS

630.05.01 Sectional Steel High Mast Lighting Poles

Sectional steel high mast lighting poles shall be according to OPSS 2471.

630.05.02 Raising and Lowering Equipment

Raising and lowering equipment shall be according to OPSS 2476.

630.07 CONSTRUCTION

630.07.01 General

General requirements for electrical work shall be as specified in the Contract Documents.

630.07.01.01 Ordering Sectional Steel High Mast Lighting Poles and Raising and Lowering Equipment

Immediately following the award of the Contract, the high mast lighting poles and the raising and lowering equipment shall be ordered, as required for this Contract. All necessary measures shall be taken to ensure sectional steel high mast lighting poles and the raising and lowering equipment are 100% compatible and fully functional.

Verification of the delivery dates of the high mast lighting poles and the raising and lowering equipment shall be obtained from the suppliers and submitted to the Contract Administrator within 72 hours after the award of the Contract.

Timely and accurate communication shall be maintained with both the Owner and the suppliers regarding the delivery, schedules, and requirements for the high mast lighting poles and the raising and lowering equipment.

Delivery and off-loading of the sectional steel high mast lighting poles and the raising and lowering equipment shall be completed in a timely and efficient manner.

630.07.02 Sectional Steel High Mast Lighting Poles and Equipment

630.07.02.01 Assembly of Sectional Steel High Mast Lighting Poles

The lifting equipment used in contact with the pole sections shall be non-abrasive in nature.

Sectional steel high mast lighting poles shall be assembled so that all sections for individual poles are matched as fabricated. The completed sectional steel high mast lighting pole shall be according to the overall tolerances specified in the Contract Documents.

630.07.02.02 Raising and Lowering Equipment

The raising and lowering equipment and the mechanical and electrical components shall be installed according to the manufacturer's specifications and recommendations.

The raising and lowering equipment manufacturer shall be present during the equipment installation to ensure proper assembly procedures and commissioning.

630.07.02.03 Pole Installation

At least 14 Days prior to the start of pole installation, the Contract Administrator shall be informed, in writing, of the pending operation.

The anchorage setting templates shall be removed prior to installation of lighting poles.

The pole shall be installed plumb, with the base plate positioned and the door orientated as specified in the Contract Documents. The pole shall have adequate support during installation. The pole shall not be considered self-supporting until all fasteners in the base are tightened by the turn-of-nut method according to CSA S6.

A 12 mm square, welded, 19 AWG galvanized steel metal mesh shall be placed around the outside circumference of the anchor bolt circle, between the pole base plate and the footing after pole installation is completed.

The orientation of the high mast lighting pole shall be as specified in the Contract Documents.

630.07.02.04 High Mast Lighting Equipment

High mast lighting equipment shall be installed as specified in the Contract Documents.

630.07.03 Quality Control

630.07.03.01 Pre-Installation Testing and Inspection

The pre-installation testing and inspection of the high mast lighting pole complete with raising and lowering equipment, including mechanical and electrical components, shall be according to manufacturer's specification and the Contract Documents.

A letter of compliance from the manufacturer of the sectional steel high mast lighting pole equipment, certifying that the sectional steel high mast lighting pole equipment is according to the Contract Documents shall be submitted to the Contract Administrator by the Contractor.

Testing on the torque limiter shall be conducted on the internal drive raising and lowering equipment and on the portable power drill for the external drive raising and lowering equipment unit. The Contractor shall ensure that the torque limiter is set and functions according to the manufacturer's recommendations. The cord connecting the control to each raising and lowering motor or portable power drill shall be a minimum length of 13 m.

630.07.03.02 Proof of Performance Testing and Inspection

The ring assembly, including luminaires, and the raising and lowering equipment shall be fully raised, latched, unlatched, and fully lowered a minimum of five times for each installed sectional steel high mast lighting pole. After each raising and lowering sequence, every piece of the raising and lowering equipment shall be inspected to ensure that all components are functioning properly and are not damaged. The cables inside the pole shall be inspected. Twisted cables shall be untwisted prior to each subsequent raising and lowering sequence.

The following shall be inspected:

- a) Winch gear and housing.
- b) Winch cable.
- c) Supporting cables.
- d) Power cable.
- e) Ring assembly.
- f) Latching system.

If problems or deficiencies occur during the testing, the test shall be stopped and the problem or deficiency corrected. Once the problem or deficiency has been corrected, the testing process of the pole and associated material shall be repeated in full.

Each ring assembly and supporting cable shall be inspected and adjusted to ensure that the ring is level.

630.07.03.02.01**Certificate of Conformance**

A Certificate of Conformance shall be submitted to the Contract Administrator upon completion of the work. The Quality Verification Engineer shall affix his or her seal and signature to the completed Certificate of Conformance confirming the following:

- a) All of the high mast equipment at each high mast pole was tested and inspected.
- b) The high mast lighting raising and lowering equipment is in general conformance with the requirements of the Contract Documents.
- c) Each sectional steel high mast lighting pole has been installed plumb with the base plate positioned as specified in the Contract Documents.
- d) Each sectional steel high mast lighting pole and raising and lowering equipment passed the proof of performance testing and inspection.
- e) The torque limiter has been fully tested and verified to be fully functional according to the manufacturer's recommendations and the Contract Documents.
- f) The sectional steel high mast lighting pole jacking and installation procedures have been carried out according to the installation drawings, calculations, and procedures.
- g) At the end of the testing at each sectional steel high mast lighting pole, the ring assembly has been levelled, raised to the top of the pole, and fully and properly docked and latched to the head frame assembly at the top of the pole.

630.07.04**Document Submission**

The service manual for the high mast lighting equipment shall document in detail the installation and operation of the high mast lighting equipment and components. It shall include clear and detailed illustrations indicating layouts of controls, displays, schematic and wiring diagrams, and other information required to correctly operate a fully assembled and operational high mast lighting unit, as well as the maintenance and service aspects of individual components.

The service manual for the high mast lighting equipment shall include part numbers and settings and options of installation and operation. The manual shall provide sections that completely describe the theory of operation using block diagrams, wiring and schematic diagrams, diagnostic and repair procedures, assembly instructions and drawings, component layout drawings, and acceptable manufacturers and suppliers of miscellaneous component parts.

Each manual for the high mast lighting equipment shall detail all major assembling, adjusting, and aligning procedures and identify all acceptable tolerances or variances. Manuals shall also include:

- a) Detailed specifications of major components.
- b) Copies of the Working Drawing specified in OPSS 2471 and OPSS 2476 reduced to 8½ x 11" paper format.
- c) Component warranty certificates.
- d) Operating instructions.
- e) All other relevant documents or drawings.

630.07.05 Management of Excess Material

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

630.08 QUALITY ASSURANCE

The Owner may make random inspections of individual high mast lighting poles, visually check for proper assembly with related equipment, and witness the raising and lowering of the ring assembly.

630.09 MEASUREMENT FOR PAYMENT

630.09.01 Actual Measurement

- 630.09.01.01 25 m Sectional Steel High Mast Lighting Poles and Equipment
30 m Sectional Steel High Mast Lighting Poles and Equipment
35 m Sectional Steel High Mast Lighting Poles and Equipment
40 m Sectional Steel High Mast Lighting Poles and Equipment
45 m Sectional Steel High Mast Lighting Poles and Equipment**

For measurement purposes, a count shall be made of the number of each size of sectional steel high mast lighting poles and equipment installed.

630.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clause under Actual Measurement.

630.10 BASIS OF PAYMENT

- 630.10.01 25 m Sectional Steel High Mast Lighting Poles and Equipment - Item
30 m Sectional Steel High Mast Lighting Poles and Equipment - Item
35 m Sectional Steel High Mast Lighting Poles and Equipment - Item
40 m Sectional Steel High Mast Lighting Poles and Equipment - Item
45 m Sectional Steel High Mast Lighting Poles and Equipment - Item**

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Progress payments shall be based on the following percentages of the Contract price for milestones accepted by the Contract Administrator:

- 35% for delivery of all high mast lighting poles and equipment
- 5% for certificate of training
- 20% for installation of all high mast lighting poles and equipment
- 40% for completed and signed Certificate of Conformance for all High Mast Lighting Poles and Equipment

Appendix 630-A, November 2016 FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

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

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Tolerances for the assembled sectional steel high mast pole. (630.07.02.01)
- Base plate positioning, door orientation, and pole orientation. (630.07.02.03)
- High mast lighting equipment installation requirements. (630.07.02.04)
- Pre-installation testing and inspection requirements. (630.07.03.01)
- Raising and lowering equipment requirements. (630.07.03.02.01)
- Torque limiter requirements. (630.07.03.02.01)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 2450.011	High Mast Lighting Pole, 25, 30, and 35 m 8-Sided Pole
OPSD 2450.021	High Mast Lighting Pole, 40 and 45 m 12-Sided Pole
OPSD 2453.000	High Mast Lighting Pole, Luminaire and Handhole Orientation
OPSD 2453.001	High Mast Lighting Pole, Luminaire and Handhole Orientation for Median Mounted Poles
OPSD 2453.010	High Mast Lighting Pole, Cable Holder and Storage Hook Details
OPSD 2453.020	High Mast Lighting Pole, Handhole Cover Hinges, Latches, and Padlock
OPSD 2453.050	High Mast Lighting Pole, Nameplate Details
OPSD 2453.060	High Mast Lighting Pole, Flood Light Luminaire Mounting Details
OPSD 2453.070	High Mast Lighting Pole, Luminaire Support Ring
OPSD 2453.080	High Mast Lighting Pole, Head Frame and Ring Assembly
OPSD 2453.090	High Mast Lighting Pole, Shroud
OPSD 2453.091	High Mast Lighting Pole, Shroud Details
OPSD 2453.140	High Mast Lighting Pole, Internal Drive Raising and Lowering Equipment - List of Components
OPSD 2453.150	High Mast Lighting Pole, Internal Drive Raising and Lowering Equipment - Layout
OPSD 2453.160	High Mast Lighting Pole, Internal Motor and Winch Details
OPSD 2453.170	High Mast Lighting Pole, Internal Drive Raising and Lower Equipment, 347/600V, 3-Phase, Wiring Diagram
OPSD 2453.180	High Mast Lighting Pole, Internal Drive Raising and Lower Equipment, 120/240V, 1-Phase Wiring Diagram
OPSD 2453.190	High Mast Lighting Pole, External Drive Raising and Lowering Equipment - List of Components
OPSD 2453.200	High Mast Lighting Pole, External Drive Raising and Lowering Equipment - Layout

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OPSD 2453.210	High Mast Lighting Pole, External Drive Raising and Lower Equipment, 347/600V, 3-Phase, Wiring Diagram
OPSD 2453.220	High Mast Lighting Pole, External Drive Raising and Lower Equipment, 120/240V, 1-Phase, Wiring Diagram



**ONTARIO
PROVINCIAL
STANDARD
SPECIFICATION**

**METRIC
OPSS.MUNI 706
NOVEMBER 2016**

(Formerly OPSS 706 2010)
(Formerly OPSS 543, December 1990)

Note: The MUNI implemented in November 2016 replaces OPSS 706 COMMON, November 2010 with no content changes.

**CONSTRUCTION SPECIFICATION
FOR TRAFFIC CONTROL SIGNING**

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706-A	Commentary

706.01	SCOPE

This specification covers the requirements for traffic control signing during construction.

706.01.01 Specification Significance and Use

This specification has been developed for use in provincial- and municipal-oriented Contracts. The administration, testing, and payment policies, procedures, and practices reflected in this specification

correspond to those used by many municipalities and the Ontario Ministry of Transportation.

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

706.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

706.02 REFERENCES

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

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

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

Canadian General Standards Board (CGSB)

CGSB 62-GP-11M, May 1978 - Marking Material, Retroreflective Enclosed Lens, Adhesive Backing

Authority Publications - Ministry of Transportation of Ontario:

Traffic Control Manual for Roadway Work Operations - Field Edition

Manual of Uniform Traffic Control Devices, M.U.T.C.D.

706.03 DEFINITIONS

Construction Signs means all traffic control signs and associated devices identified in Part A, Division 5, Temporary Conditions, M.U.T.C.D. Manual, including vehicles and sign trailers, required to support signs and equipment to supply sign lighting, excluding the contract identification sign and highway number markers.

Manual means the "Traffic Control Manual for Roadway Work Operations", Field Edition and the Manual of Uniform Traffic Control Devices, M.U.T.C.D.

706.05 MATERIALS

706.05.01 Reflective Surfaces

Reflective materials and surfaces shall conform to M.U.T.C.D.

706.05.02 Signs

All details with respect to materials, dimensions and other requirements except reflectivity, shall conform to the M.U.T.C.D.

706.07 CONSTRUCTION

706.07.01 Traffic Control Signing

Traffic control signing shall include the work of supplying, locating, relocating, erecting, operating and maintaining construction signs, and shall conform to the Manual unless otherwise specified. The contract identification signs will be supplied, erected, and maintained by the Authority.

Signs shall be in place before work affecting traffic begins, shall be well maintained to be effective at all times, shall remain operational throughout the duration of the operation requiring signs, including the shutdown period, and shall be removed upon completion of the operation.

Ramps or roadways identified in the contract for complete closure shall be signed conforming to the M.U.T.C.D.

706.07.02 Existing Signing

Any existing signs removed by the Contractor to accommodate construction shall be kept operational by placement on a temporary support and shall be reinstalled conforming to the M.U.T.C.D after the work operation is complete. Temporarily relocated existing signs shall be kept at the same height, offset and basic location from traffic as before removal.

706.07.03 Seasonal Shutdown

During seasonal shutdown, the Authority will take responsibility for the maintenance, including replacement, of construction signs unless otherwise specified.

Responsibility for the maintenance of construction signs during seasonal shutdown will not be assumed by the Authority until the signing has been inspected, sign installation deviations from the Manual corrected and signing approved in writing by the Authority.

Construction signs placed, replaced or repaired by the Authority during seasonal shutdown will become the property of the Contractor.

Upon resumption of operations, the Contractor shall review and provide written acceptance of the signing; deviations from the Manual shall be noted and these will be corrected by the Authority. Once deviations are repaired, the Contractor shall resume responsibility as specified herein.

706.10**BASIS OF PAYMENT****706.10.01****Traffic Control Signing - Lump Sum Item**

Payment at the contract price for the above item shall be full compensation for all labour, equipment and material required to do the work.

For progress payment, fifty percent of the contract price will be paid upon the supply and installation of the complete initial traffic control signing plan. The balance will be prorated over the balance of the working period.

Appendix 706-A, November 2010
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

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

Designer Action/Considerations

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR STEEL BEAM GUIDE RAIL AND CABLE GUIDE RAIL

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721.04	DESIGN AND SUBMISSION REQUIREMENTS - Not Used
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APPENDICES

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

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

721.01.02 Appendices Significance and Use

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

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 501 Compacting

Ontario Provincial Standard Specifications, Material

OPSS 1350 Concrete - Materials and Production
OPSS 1503 Cable Guide Rail
OPSS 1504 Steel Beam Guide Rail
OPSS 1505 Channel Components for Steel Beam Guide Rail
OPSS 1601 Wood, Preservative Treatment, and Shop Fabrication

Ontario Ministry of Transportation Publications

Ontario Traffic Manual (OTM):
Book 11 - Pavement, Hazard and Delineation Markings

CSA Standards

G164-M92 (R2003) Hot Dip Galvanizing of Irregularly Shaped Articles
O56-10 (R2015) Round Wood Piles

ASTM International

A 36/A 36M-14	Carbon Structural Steel
A 780/A 780M-09 (2015)	Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
D 4956-16a	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
Steel Beam Barricade**

Measurement of steel beam guide rail shall be by length in metres along the centreline of the system from end to end of each steel beam guide rail installation and does not include the terminal systems.

**721.09.01.06 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 and includes the end treatments 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
Steel Beam Barricade – Item**

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

When there is not a separate tender item for steel beam guide rail structure connections, payment at the Contract price for single rail steel beam guide rail with channel shall include full compensation for all labour, Equipment, and Material to do the work of connecting steel beam guide rail to a structure.

Costs associated with any required repairs or removal and replacement of defective materials shall be the Contractor's responsibility at no additional cost to the Owner.

**Appendix 721-A, November 2016
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS**

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

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Guide rail system locations. (721.07.01)
- Cable guide rail to be adjusted. (721.07.02.04)
- Cable guide rail post to be replaced. (721.07.02.05)
- Steel beam guide rail to be adjusted. (721.07.03.04)

Leaving end treatment should be used on divided highways and ramps, when the leaving end of the installation is located beyond the clear zone for opposing traffic.

Height adjustments for steel beam guide rail with wooden post shall be a minimum of 50 mm.

Cable Guide Rail Adjustment:

Mounting height tolerances for cable guide rail (CGR) are provided in the MTO Roadside Safety Manual. The purpose of the Adjust Cable Guide Rail item is to allow for the adjustment of the mounting height of an existing CGR installation. Generally, adjustment is necessary at locations where the pavement rehabilitation strategy will raise the existing ground elevation adjacent to an existing guide rail installation. An evaluation of existing guide rail will provide the designer with an inventory of the type of existing guide rail systems as well as the existing mounting height.

When adjusting CGR systems, the posts remain in their current location and the cables are reinstalled at the new mounting height. If the CGR was installed according to OPSD 913.130, there should be approximately 150 mm of space available for adjustment assuming that this is the first adjustment. Cables are not to be installed within 200 mm of the top of the posts. This ensures that the cables do not interfere with the reflectorized strip.

The Adjust Cable Guide Rail tender item also includes the removal and replacement of cable clamps and nails, the installation of one new turnbuckle per cable between anchor blocks, and the installation of new reflectorized strips.

When the evaluation of the existing CGR indicates that the posts are in unsound condition, out of plumb, or cannot meet the mounting height tolerance, it may be necessary to replace some or all of the posts. The Cable Guide Rail Post Replacement tender item can be used to replace existing cable guide rail posts when the remainder of the components (i.e., cables and anchor blocks) are in satisfactory condition.

Appendix 721-A

Steel Beam Guide Rail Adjustment:

Mounting height tolerances for steel beam guide rail (SBGR) are specified in OPSS 721. There are three tender items available for adjustment of SBGR. The purpose of these items is to allow for the adjustment of the mounting height of an existing SBGR installation on wooden or steel posts. Generally, adjustment is necessary at locations where the pavement rehabilitation strategy will raise the existing ground elevation adjacent to an existing guide rail installation. An evaluation of the existing guide rail will provide the designer with an inventory of the type of existing guide rail systems as well as existing mounting height. Existing SBGR installations may consist of the following configurations:

a) Wooden posts with wooden offset blocks:

Although still installed today, these systems were used primarily in the years prior to implementation of SBGR on steel posts in 1995. When adjusting these systems, the posts remain in their current location, but the offset block and rail (and channel, where necessary) are reinstalled at the new mounting height. If the guide rail was installed according to OPSD 912.140, there should be approximately 150 mm of space available for adjustment assuming this is the first adjustment. The evaluation of existing guide rail should determine whether the existing installation can accommodate the proposed change in height.

b) Steel post with steel offset blocks:

Steel post systems have been the most common since they were first implemented in 1995 mainly due to their relative ease of handling and installation. Steel offset blocks were used exclusively with steel post systems from 1995 through 2002 when the standard was revised to specify routed wooden blocks. When they are adjusted, existing steel post systems with steel offset blocks will be retrofitted with routed wooden or plastic offset blocks. This requires the punching of a new hole to accommodate the wooden or plastic offset block.

c) Steel posts with wooden or plastic offset blocks:

From 2003 through the early 2008, steel post systems were installed exclusively with routed wooden offset blocks. In 2008, plastic offset blocks were implemented as an alternative to the routed wooden offset blocks. Since that time, steel post systems with plastic offset blocks have been the most common steel beam system.

Selection of the appropriate tender item for each installation will ensure that the Contractor will address the unique adjustment requirements of each system configuration.

Tender items for adjustment include the removal and replacement of existing hardware including bolts, washers, and nuts as well as the installation of new reflectors. For SBGR with steel offset blocks, replacement of steel offset blocks with plastic or wooden offset blocks is included.

Existing end terminals and treatments should be reviewed when SBGR is being considered for adjustment.

Existing end terminals may consist of eccentric loader terminal (ELT) systems, extruder terminal (ET) systems, or sequential kinking terminal (SKT) systems:

a) ELT Systems:

- Consider replacement of ELT installations that are greater than or equal to 5 years in age with a new steel beam energy attenuating terminal (SBEAT) system. If the ELT system is located on a horizontal curve with a radius of less than 190m, a new ELT should be installed.

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b) SBEATs:

- Existing ET and SKT systems consist of several different variations on wooden and steel posts.
- Consider replacement of ET and SKT system installations on wooden posts with a new SBEAT System.
- ET and SKT systems on steel posts that are in good condition may be adjusted.

Existing leaving end treatments consisting of buried leaving end treatments (formerly OPSD 912.233) or upright fishtail ends:

- Buried leaving end treatments are a challenge to adjust and could be replaced with a standard leaving end treatment according to OPSD 912.235. This would require the removal of 16 m of existing SBGR and subsequent installation of 4 m of new SBGR according to OPSD 912.235.
- Existing upright fishtail type end treatments typically have been installed based on the extension requirements for unanchored guide rail in accordance with Table 3.4.2 in the MTO Roadside Safety Manual. When replacing an upright fishtail end treatment with a standard leaving end treatment, ensure that after removal of the unanchored end beyond the hazard that the 4 m of new SBGR in accordance with OPSD 912.235 extends beyond the hazard by 4 m.
- Where an existing buried end treatment or upright fishtail end treatment is on the leaving end of a SBGR installation located on an undivided highway or at a location on a divided highway where the end of the SBGR is located within the clear zone for opposing traffic, the treatment should be considered for replacement with an end terminal.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 912.130	Guide Rail System, Steel Beam, Steel Post With Offset Block Assembly, Installation - Single Rail
OPSD 912.140	Guide Rail System, Steel Beam, Wooden Post Assembly, Installation - Single Rail
OPSD 912.141	Guide Rail System, Steel Beam, Wooden Post Assembly, Installation - Double Rail
OPSD 912.234	Guide Rail System, Steel Beam, End Treatment, Installation - Leaving End Collector Median
OPSD 912.235	Guide Rail System, Steel Beam, Leaving End Treatment, Installation
OPSD 912.240	Guide Rail System, Steel Beam, Treatment at Culverts With Minimal Cover Installation - Single Rail
OPSD 912.380	Guide Rail System, Steel Beam, Permanent Transition Installation, Channel Termination, Median
OPSD 912.430	Guide Rail System, Steel Beam, Structure Connection
OPSD 912.480	Guide Rail System, Steel Beam, Permanent Connection Installation, Single Steel Beam to Concrete Barrier
OPSD 912.481	Guide Rail System, Steel Beam, Permanent Connection Installation, Double Steel Beam to Concrete Barrier
OPSD 912.530	Guide Rail System, Steel Beam, Structure Approach Treatment, Installation - Rural Highway
OPSD 912.531	Guide Rail System, Steel Beam, Installation - Entrances and Intersecting Roadways
OPSD 913.130	Guide Rail System, Cable, Installation – Shoulder
OPSD 973.130	Fence, Steel Beam, Barricade, Installation



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

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

723.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

723.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 314	Untreated Granular Subbase, Base, Surface Shoulder, and Stockpiling
OPSS 510	Removal
OPSS 705	Flexible Delineator Posts
OPSS 740	Concrete Barriers
OPSS 904	Concrete Structures

Ontario Provincial Standard Specifications, Material

OPSS 1350	Concrete - Materials and Production
OPSS 1440	Steel Reinforcement for Concrete

Ontario Ministry of Transportation Publications

Ontario Traffic Manual (OTM):
Book 6 - Warning Signs

ASTM International

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.

When a specific energy attenuator system is specified in the Contract Documents, there shall not be an option of substitution for the energy attenuator system.

723.05.03 Concrete

Concrete for pads and anchor blocks shall be according to OPSS 1350 with a nominal minimum 28-Day compressive strength of 30 MPa.

723.05.04 Steel Reinforcement

Steel reinforcement shall be according to OPSS 1440.

723.05.05 Anchor Bolts

Anchor bolts shall be supplied and installed according to energy attenuator manufacturer recommendations.

723.05.06 Bolts for Connection of BB-BEAT System to Concrete Barrier

Bolts used to connect the BB-BEAT system to the concrete barrier shall be according to ASTM 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 New Concrete Pads

The concrete pad shall be as specified by the manufacturer.

723.07.03.02 Existing Concrete Surface

Existing 200 mm minimum thick concrete surfaces, pads, or precast pads may be used to support the energy attenuator.

723.07.03.03 Asphalt Over Concrete

Existing or new 75 mm minimum thick asphalt over 75 mm minimum thick concrete pavement may be used to support the energy attenuator.

723.07.03.04 Asphalt Over Compacted Granular

Existing or new 150 mm minimum thick asphalt over 150 mm minimum thick compacted granular base may be used to support the energy attenuator. The asphalt shall extend a minimum of 500 mm beyond the anchor bolts.

723.07.03.05 Reduced Exposure

When water filled energy attenuator systems are in use, the temperature shall be monitored on a daily basis. When the temperature is predicted to fall below freezing, antifreeze agents according to manufacturer recommendations shall be added to the water. The use of a water filled energy attenuator system when frozen is not permissible.

Water filled energy attenuator systems shall not be left in place during a seasonal shutdown period without approval from the Contract Administrator. When approval from the Contract Administrator is not granted, water filled energy attenuator systems shall be replaced with another approved energy attenuator listed for the reduced exposure tender item for the duration of the seasonal shutdown period.

Disposal of liquid materials shall be managed according to the Contract Documents.

723.07.03.06 Dual Duty

A new high exposure energy attenuator shall be supplied and installed in a temporary configuration during construction at the locations specified in the Contract Documents.

723.07.03.07 Relocation

Temporary energy attenuators, object markers, oversize snowplow markers, object marker posts, and flexible delineator posts shall be relocated as specified in the Contract Documents, including the removal of existing and installation of new anchor bolts and mounting hardware.

Prior to completion of the Contract, dual duty energy attenuators and associated object markers, oversize snowplow markers, and object marker posts including the replacement of anchor bolts and mounting hardware, shall be relocated to their permanent locations as specified in the Contract Documents and in accordance with the General and Permanent Installation subsections.

723.07.03.08 Permanent and Temporary Concrete Barriers

Temporary concrete barriers shall be modified and installed as specified in the Contract Documents and the modified surfaces shall be smooth. Temporary concrete barriers shall be anchored as specified in the Contract Documents.

Permanent existing concrete barriers shall be modified as specified in the Contract Documents and the modified surfaces shall be smooth.

723.07.04 Delineation

723.07.04.01 Object Markers and Oversize Snowplow Markers

A Wa-33 object marker according to OTM Book 6, a Wz-2 oversize snowplow marker, and galvanized mounting hardware shall be installed at each energy attenuator.

When installed on a paved surface, the object marker and oversize snowplow marker shall be integrally attached to a surface mounted flexible post. The signs and post shall be supplied by the manufacturer as a complete unit. The post shall have the ability to bend 90° from vertical and self-restore after impacts. The minimum outside diameter of the post shall be 60 mm. The post shall be anchored to the pavement according to manufacturer's recommendations.

When installed on a granular surface, the Wa-33 object marker and Wz-2 oversize snowplow marker shall be securely fastened to a U channel post and the post shall be direct buried to a minimum embedment depth of 900 mm.

Posts shall be installed at locations specified in the Contract Documents.

723.07.04.02 Flexible Delineator Posts

Flexible delineator posts shall be installed according to OPSS 705 at locations specified in the Contract Documents.

723.07.05 Management of Excess Material

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

723.09	MEASUREMENT FOR PAYMENT
723.09.01	Actual Measurement
723.09.01.01	Energy Attenuator - Permanent, Narrow Energy Attenuator - Permanent, Wide Energy Attenuator - Permanent, Extra Wide Energy Attenuator - Permanent, Super Wide Energy Attenuator - Permanent, High Exposure Energy Attenuator - Permanent, Single-Sided Box Beam Bursting Energy Absorbing Terminal System - Permanent Quadguard System - Permanent Quadguard Wide System - Permanent Quadguard Extra Wide System - Permanent Quadguard Super Wide System - Permanent QuadTrend System - Permanent Smart System - Permanent TRACC System - Permanent TAU-II System - Permanent TAU-II Wide System - Permanent TAU-II Extra Wide System - Permanent

For measurement purposes, a count shall be made of the number of complete energy attenuator systems installed.

723.09.01.02	Energy Attenuator - Temporary, Narrow Energy Attenuator - Temporary, Wide Energy Attenuator - Temporary, Extra Wide Energy Attenuator - Temporary, Super Wide Energy Attenuator - Temporary, Reduced Exposure Energy Attenuator - Temporary, Dual Duty ABSORB 350 System - Temporary ACZ-350 System - Temporary Quadguard System - Temporary Quadguard Wide System - Temporary Quadguard Extra Wide System - Temporary Quadguard Super Wide System - Temporary SLED System - Temporary Smart System - Temporary TAU-II System - Temporary TAU-II Wide System - Temporary TAU-II Extra Wide System - Temporary TRACC System - Temporary

For measurement purposes, a count shall be made of the number of complete energy attenuator systems installed and removed, up to the maximum number of systems required to be in place at any one time during the Contract.

723.09.01.03	Energy Attenuator - Relocation, Narrow Energy Attenuator - Relocation, Wide Energy Attenuator - Relocation, Extra Wide Energy Attenuator - Relocation, Super Wide Energy Attenuator - Relocation, Reduced Exposure Energy Attenuator - Relocation, Dual Duty ABSORB 350 System - Relocation ACZ-350 System - Relocation

Quadguard System - Relocation
 Quadguard Wide System - Relocation
 Quadguard Extra Wide System - Relocation
 Quadguard Super Wide System - Relocation
 SLED System - Relocation
 Smart System - Relocation
 TAU-II System - Relocation
 TAU-II Wide System - Relocation
 TAU-II Extra Wide System - Relocation
 TRACC System - Relocation

For measurement purposes, a count shall be made of the number of complete energy attenuator systems relocated. Systems that are temporarily surplus and are required for future stages shall be paid for as one relocation for the combined moves into and out of storage, including any off-site storage required due to on-site restrictions.

723.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

723.10 BASIS OF PAYMENT

723.10.01 Energy Attenuator - Permanent, Narrow - Item
 Energy Attenuator - Permanent, Wide - Item
 Energy Attenuator - Permanent, Extra Wide – Item
 Energy Attenuator - Permanent, Super Wide – Item
 Energy Attenuator - Permanent, High Exposure - Item
 Energy Attenuator - Permanent, Single-Sided - Item
 Box Beam Bursting Energy Absorbing Terminal System - Permanent - Item
 Quadguard System - Permanent - Item
 Quadguard Wide System - Permanent - Item
 Quadguard Extra Wide System - Permanent - Item
 Quadguard Super Wide System - Permanent - Item
 QuadTrend System - Permanent - Item
 Smart System - Permanent - Item
 TAU-II System - Permanent - Item
 TAU-II Wide System - Permanent - Item
 TAU-II Extra Wide System - Permanent - Item
 TRACC System - Permanent - Item
 Energy Attenuator - Temporary, Narrow - Item
 Energy Attenuator - Temporary, Wide - Item
 Energy Attenuator - Temporary, Extra Wide - Item
 Energy Attenuator - Temporary, Super Wide - Item
 Energy Attenuator - Temporary, Reduced Exposure - Item
 Energy Attenuator - Temporary, Dual Duty - Item
 ABSORB 350 System - Temporary - Item
 ACZ-350 System - Temporary - Item
 Quadguard System - Temporary - Item
 Quadguard Wide System - Temporary - Item
 Quadguard Extra Wide System - Temporary - Item
 Quadguard Super Wide System - Temporary - Item
 SLED System – Temporary - Item
 Smart System - Temporary - Item
 TAU-II System - Temporary - Item

TAU-II Wide System - Temporary - Item
TAU-II Extra Wide System - Temporary - Item
TRACC System - Temporary - Item
Energy Attenuator - Relocation, Narrow - Item
Energy Attenuator - Relocation, Wide - Item
Energy Attenuator - Relocation, Extra Wide - Item
Energy Attenuator - Relocation, Super Wide - Item
Energy Attenuator - Relocation, Reduced Exposure - Item
Energy Attenuator - Relocation, Dual Duty - Item
ABSORB 350 System - Relocation - Item
ACZ-350 System - Relocation - Item
Quadguard System - Relocation - Item
Quadguard Wide System - Relocation - Item
Quadguard Extra Wide System - Relocation - Item
Quadguard Super Wide System - Relocation - Item
SLED System - Relocation - Item
Smart System - Relocation - Item
TAU-II System - Relocation - Item
TAU-II Wide System - Relocation - Item
TAU-II Extra Wide System - Relocation - Item
TRACC System - Relocation - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

When the Contract contains separate items for the work required by this specification, payment shall be at the Contract price and according to the specification for such work.

Costs associated with any required removals and replacement or repairs of defective work and materials shall be the Contractor's responsibility at no additional cost to the Owner.

TABLE 1
Energy Attenuator, Permanent

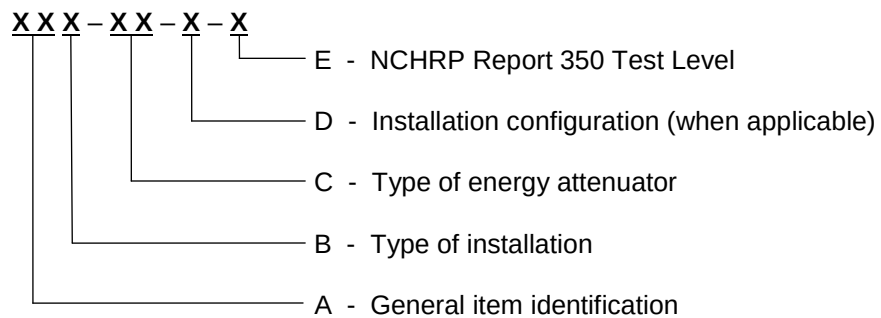
Energy Attenuator	NCHRP Report 350 Test Level		Permanent Installation					
	TL-2	TL-3	Narrow (NA)	Wide (WI)	Extra Wide (EW)	Super Wide (SW)	High Exposure (HE)	Single- Sided (SS)
BB-BEAT	No	Yes	No	No	No	No	No	Yes
Quadguard System	Yes	Yes	Yes	No	No	No	No	No
Quadguard Wide System	Yes	Yes	No	Yes	No	No	No	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
Smart System	Yes	Yes	Yes	No	No	No	Yes	No
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

TABLE 2
Energy Attenuator, Temporary

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)
ABSORB 350 System	Yes	Yes	Yes	No	No	No	No	No
ACZ 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
SLED System	Yes	Yes	Yes	No	No	No	No	No
Smart System	Yes	Yes	Yes	Yes	No	No	No	Yes
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
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 2016 FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

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

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Energy attenuator system locations using the notation shown in Table 3. (723.07.01)
- Relocation of energy attenuators using the notation shown in Table 3. (723.07.01 and 723.07.03.06)

The designer should specify whether each system is TL-2 or TL-3 configuration. TL-2 configurations are required for low-speed installations with posted speeds of less than 70 km/h. TL-3 configurations are required for high-speed installations with posted speeds of 70 km/h and greater. Single-sided systems are only available in a TL-3 configuration. (723.07.01)

A permanent energy attenuator installation should include a new concrete pad (723.07.02.01). If an existing concrete surface or pad can be used to support the system, it should be specified in the Contract Documents (723.07.02.02). The designer should confirm that the existing concrete surface or pad is in good condition and will provide a smooth operating surface for the system.

The designer should confirm that one of the following foundation options is available for each temporary energy attenuator installation (723.07.03):

- a) Existing concrete surface:
 - minimum 200 mm deep, 28 MPa minimum compressive strength
- b) Asphalt over compacted granular:
 - minimum 150 mm asphalt over 150 mm minimum compacted granular
 - the asphalt must extend a minimum of 500 mm beyond the anchor bolts
- c) Asphalt over concrete
 - minimum 75 mm asphalt over 75 mm minimum concrete, 28 MPa minimum compressive strength

The designer should confirm that the existing surface is in good condition and will provide a smooth operating surface for the system.

When a single-sided system is connected to existing concrete barrier as specified in the Contract Documents, the designer should include payment in the Contract Documents for the removal of the 4.0 m section of existing concrete barrier and placement of a new 4.0 m section adjacent to each system. (723.07.02.03)

Single-sided systems shall be installed with grading according to OPSS 202.033. Single-sided systems should not be installed in a location where backside hits towards the concrete barrier are possible (e.g., in gore areas), or in a narrow median where backside opposite direction hits are possible. The area behind and beyond the end terminal should be traversable and free of fixed objects. The minimum recommended rectangular area should be 6 m wide, measured behind and perpendicular to the back of the rail, by 22 m long, measured from the front face of the system and parallel to the system. (723.07.02.03)

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When the reduced exposure tender item is selected, the designer should confirm that the following requirements for water filled energy attenuator systems are satisfied (723.07.03.04):

- a) Water filled energy attenuator systems shall be installed at an offset of not less than 1.0 m from the edge of the travelled way.
- b) When installed adjacent to an existing guide rail system, the clearance shall be less than or equal to 0.3 m or greater than or equal to 3.0 m. Otherwise, the area behind and beyond the water filled energy attenuator system shall be traversable and free of fixed objects. The minimum recommended rectangular area shall be 6 m wide, measured behind and perpendicular to the back of the system, by 22 m long, measured from the front face of the system and parallel to the system.
- c) At a minimum, the first 16 m of temporary concrete barrier shall be placed tangential to the water filled energy attenuator system.

When the item for payment is Energy Attenuator, the designer should not include any drawings for specific energy attenuators in the Contract Documents.

Wherever possible, the designer should eliminate the use of curb with gutter in advance of and along the length of end treatments and crash cushions. See MTO Roadside Safety Manual for additional information.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 202.033	Roadway Widening, Single Sided Energy Attenuating Terminals, Approach End
OPSD 922.131	Energy Attenuator, Crash Cushion, QuadTrend System, Installation - Concrete Barrier
OPSD 922.133	Energy Attenuator, Crash Cushion, QuadTrend System, Installation - Concrete Pad and Rear Cable Anchor Block
OPSD 923.001	Energy Attenuator, Crash Cushion, Narrow Systems, Component - Reinforced Concrete Pad
OPSD 923.002	Energy Attenuator, Crash Cushion, Component - Anchor Assembly
OPSD 923.004	Energy Attenuator, Crash Cushion, Wide Systems, Component - Reinforced Concrete Pad
OPSD 923.005	Energy Attenuator, Crash Cushion, Extra Wide Systems, Component - Reinforced Concrete Pad
OPSD 923.006	Energy Attenuator, Crash Cushion, Quadguard Super Wide System, Component - Reinforced Concrete Pad
OPSD 923.010	Energy Attenuator, Crash Cushion, Narrow Systems, Component – Reinforced Precast Concrete Pad for Permanent Installation
OPSD 923.011	Energy Attenuator, Crash Cushion, Component – Reinforced Precast Concrete Pad for Modified Temporary Concrete Barrier
OPSD 923.180	Energy Attenuator, Crash Cushion, Quadguard System, Installation - Temporary, Unidirectional
OPSD 923.181	Energy Attenuator, Crash Cushion, Quadguard System, Installation - Temporary, Bidirectional
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**CONSTRUCTION SPECIFICATION FOR
GUIDE RAIL END TREATMENT - STEEL BEAM
ENERGY ATTENUATING TERMINAL SYSTEMS**

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732-A	Commentary

732.01	SCOPE

This specification covers the requirements for the installation of steel beam energy attenuating terminal (SBEAT) systems.

732.01.01 Specification Significance and Use

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

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

732.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

732.02 REFERENCES

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

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

Ontario 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 locations specified in the Contract Documents.

When a SBEAT system is specified in the Contract Documents, the Contractor has the option of using one of the following systems:

- a) Extruder Terminal system
- b) Sequential Kinking Terminal system
- c) X-Lite Tangent Terminal system
- d) SoftStop Terminal system

When a specific SBEAT system is specified in the Contract Documents, there shall be no option of substitution for the SBEAT system.

SBEAT systems with steel posts shall be installed to steel beam guide rail systems with steel posts.

SBEAT systems 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 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 mounting heights shall be measured vertically from the top of the steel beam guide rail to the ground or gutter line. SBEAT system mounting heights shall be within the ranges in Table 1.

Where curb with gutter is required, steel beam guide rail mounting height shall be measured:

- a) Vertically at face of steel beam guide rail, when face of steel beam guide rail is more than 300 mm beyond gutter line.
- b) Vertically at gutter line, when face of steel beam guide rail is 300 mm or less beyond the gutter line.

Channel shall not be used within the SBEAT system.

732.07.04 Damage to Galvanizing

Precautions shall be taken to protect galvanizing against damage. Minor abrasions shall be repaired according to ASTM A 780/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
Extruder Terminal-System
Sequential Kinking Terminal System
X-Lite Tangent Terminal System
SoftStop 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
Extruder Terminal System - Item
Sequential Kinking Terminal System – Item
X-Lite Tangent Terminal System – Item
SoftStop Terminal System – Item**

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Costs associated with any required removals and replacement or repairs of defective work and materials shall be the Contractor's responsibility at no additional cost to the Owner.

TABLE 1
SBEAT System Mounting Heights

System	Height During Construction and Seasonal Shutdown mm	Height for Completion of the Work mm
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

Appendix 732-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

The designer should specify the following in the Contract Documents:

- Steel beam energy attenuating terminal system locations. (732.07.01)
- Depth and alignment of system. (732.07.02)

The steel beam energy attenuating terminal system should be installed flared; however, the system may be installed tangent to the roadway, if grading requirements cannot be met.

The steel beam energy attenuating terminal system should not be installed on roadway with centreline curves less than 250 m radius.

Each steel beam energy attenuating terminal system unit comes from the supplier with all components required for its installation, including posts and steel beam guide rail elements for the length of the system.

Reflective sheeting is normally supplied with each steel beam energy attenuating terminal system. The designer should determine if the sheeting is not required and, if so, specify it in the Contract Documents.

Wherever possible, the designer should eliminate the use of curb with gutter, in advance of and along the length of end treatments and crash cushions. See MTO Roadside Safety Manual for additional information.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 912.124	Guide Rail System, Steel Beam, Type M Transition Rail, Component
OPSD 912.125	Guide Rail System, Steel Beam, Type M Rail, Component
OPSD 912.127	Guide Rail System, Steel Beam, M20 Steel Post With Offset Block, Component
OPSD 912.130	Guide Rail System, Steel Beam, Steel Post With Offset Block Assembly, Installation - Single Rail
OPSD 912.140	Guide Rail System, Wooden Post Assembly, Installation - Single Rail
OPSD 922.161	Energy Attenuator, End Treatment, Steel Beam Energy Attenuating Terminal, SoftStop Terminal System, Installation
OPSD 922.170	Energy Attenuator, End Treatment, Steel Beam Energy Attenuating Terminal, X-Lite Tangent Terminal System With Steel Posts, Installation
OPSD 922.180	Energy Attenuator, End Treatment, Steel Beam Energy Attenuating Terminal, Sequential Kinking Terminal System With Wooden Posts, Installation
OPSD 922.181	Energy Attenuator, End Treatment, Steel Beam Energy Attenuating Terminal, Sequential Kinking Terminal System With Steel Posts, Installation
OPSD 922.530	Energy Attenuator, End Treatment, Steel Beam Energy Attenuating Terminal, ET Plus System With Wooden Posts, Installation

OPSD 922.532	Energy Attenuator, End Treatment, Steel Beam Energy Attenuating Terminal, ET Plus System With Steel Posts, Installation
OPSD 984.201	Energy Attenuator, End Treatment, Delineation, Installation - Approach End
OPSD 984.202	Energy Attenuator, End Treatment, Delineation, Installation - Leaving End



CONSTRUCTION SPECIFICATION FOR 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 municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

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

771.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

771.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 510 Removal

Ontario Provincial Standard Specifications, Material

OPSS 1540 Standard Highway Fence Components

ASTM International

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 948-12-9.75 shall be set diagonally to the grain of the wooden post and driven securely. Top wire shall be double stapled and all other wires single stapled.

Staples for fence fabric with design number 949-12-12.5 shall be set diagonally to the grain of the wooden post and driven securely, but shall allow for movement of the horizontal line wires as a result of thermal expansion and contraction.

Fence fabric shall be fastened to the steel post using wire ties at all nine line wires.

Fencing fabric shall be tensioned and properly terminated with the wire wrapped around the terminal posts at least once and around itself at least four complete turns and stapled to the terminal posts.

Rolls of fence fabric with design numbers 949-12-9 and 948-12-9.75 shall be spliced together by wrapping adjacent line wires using mechanical splicing units or using crimp sleeves. The same method shall be used throughout the limits of the Contract.

Rolls of fence fabric with design number 949-12-12.5 shall be spliced together using mechanical splicing units or crimp sleeves.

When splicing is achieved by wrapping adjacent line wires, wrap the overhanging line wires around the corresponding line wires on the adjacent roll, at least four complete turns as specified in the Contract Documents.

Mechanical splicing units and crimp sleeves shall be installed according to the manufacturer's instructions and as specified in the Contract Documents.

After splicing, all projecting ends of the line wires shall be removed. Terminal posts shall not be installed for splice purposes only.

771.07.04 Cross Fences

Cross fences shall be secured to the adjacent post prior to cutting the fence at the brace panel.

771.07.05 Gates

Gates shall be installed at locations and be of the type and size as specified in the Contract Documents.

When gates are required without adjacent fencing, terminal posts with brace panels shall be installed on each side of the gate.

Gates shall be installed to open away from the roadway and to close by gravity.

771.07.06 Marking

Identification plates, provided by the material supplier, shall be securely attached to the completed fence installation at the following intervals:

- a) At the start and end of each fence installation.
- b) At a maximum interval of 300 m.

The fence identification plate shall be located within 300 mm of a terminal post with the top of the plate located approximately 300 mm from the top of the fence fabric. The maximum dimensions of the plate shall be 200 by 200 mm. The plate shall be made from 0.81 mm thick anodized aluminum sheet according to ASTM 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 2016 FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

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

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Highway fence locations. (771.07.03.01)
- Brace panel locations. (771.07.03.03) Brace panels are computed in accordance with the following requirements:
 - a) At cross fences (separating property owners) - 3 panels required; one forming part of the cross fence, and two installed as part of the highway fence.
 - b) At cross fences (not separating property owners) - 1 panel is required to be installed on the cross fence at the straining post.
 - c) At all horizontal angles exceeding 22 degrees - 2 panels.
 - d) On all curves of radius 900 m or less - 2 panels at each end of curve and plus 2 panels at midpoint.
 - e) Gate locations and openings - 2 panels at each site in fence.
 - f) At all vertical angles exceeding 22 degrees - 2 panels.
 - g) At crossings of watercourses (maximum span: 6 m) - 2 panels.
 - h) Terminals - 1 panel per terminal.
 - i) Existing fence (adjacent to a removed section) - 1 panel per terminal.
 - j) New fence - on clear fence runs with none of the above cases - 2 panels at approximately 200 m intervals, with a maximum interval of 230 m.
- Gate locations, types, and sizes. (771.07.05)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 971.101	Fence, Highway, In Earth, Shale, Loose Rock, or Friable Rock, Installation
OPSD 971.102	Fence, Highway, In Solid Rock, Installation
OPSD 971.103	Fence, Highway, Installation Details



CONSTRUCTION SPECIFICATION FOR SEED AND COVER

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804-A	Commentary

804.01 SCOPE

This specification covers the requirements for seeding with either rolled erosion control products or hydraulically applied erosion control products.

804.01.01 Specification Significance and Use

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

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

804.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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.

804.02 REFERENCES

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

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

Ontario Ministry of Transportation Publication

Seeding and Cover Quality Assurance Visual Inspection Field Guide

Canadian and Provincial Statutes

Canada Fertilizers Act (R.S., 1985, c. F-10)

Canada Seeds Act (R.S., 1985, c. S-8)

804.03 DEFINITIONS

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

Cover means any approved or specified material such as rolled erosion control products, (i.e., blankets) or hydraulically applied erosion control products (i.e., hydraulic mulch, bonded fibre matrix, fibre reinforced matrix) applied at the time of seeding to provide temporary erosion control and protection of the germinating seed.

Cultivate means to prepare and work the soil with agricultural implements to provide a specified depth of loose, friable soil as a suitable medium to germinate seed.

Fibre Reinforced Matrix (FRM) means any approved or specified hydraulically applied erosion control product applied to provide cover, in which mechanical and chemical bonding techniques including water resistant tackifiers and flocculants are used to interlock fibres together to form a matrix that bonds to the soil surface.

Seeded Earth Area means the prepared earth area that has received the applied seed and fertilizer.

Uniform, Cohesive Mat means an application of cover that is unvarying in consistency and when all of the cover material particles are consolidated and adhere together to produce a solid layer that protects the seeded earth area from heat and adverse environmental conditions, yet allows moisture to percolate into the underlying soil.

Waterbody means any permanent or intermittent, natural or constructed body of water including lakes, ponds, wetlands and watercourses, but does not include sewage works as defined in the Ontario Water Resources Act.

804.04 DESIGN AND SUBMISSION REQUIREMENTS

804.04.01 Submission Requirements

A legible, valid Certificate of Seed Analysis from a seed testing laboratory approved by the Canadian Food Inspection Agency for all single seed species and all seed mixtures to be used on the Contract shall be provided to the Contract Administrator 24 hours prior to any seeding operations.

804.05 MATERIALS

804.05.01 Seed

804.05.01.01 Grade Standards

All seed supplied, either as single seed species or as a seed mix shall comply with the provisions of the Canada Seeds Act and Regulations and the grade standards for that particular seed type.

Birdsfoot Trefoil mix shall contain only certified Blue Tag Leo Birdsfoot Trefoil.

804.05.01.02 Certificate of Seed Analysis

The Certificate of Seed Analysis shall stipulate the seed supplier's lot designation numbers.

Test results from the Certificate of Seed Analysis shall specify germination and purity for each seed species of the mix, as well as the seed mix composition expressed as a percentage of each seed species by mass for each seed mix specified in the Contract Documents. Test results shall comply with the values shown in Table 1 for the various seed mixes.

804.05.01.03 Seed Packaging, Labelling, and Storage

All seed and seed mixes shall be in the original factory sealed package with the original legible label securely attached.

Labelling shall be in accordance with the requirements of the Canada Seeds Act and Regulations. Each package shall be labelled to show:

- a) The name and address of the seed supplier.

- b) The name of the seed mix and the various individual seed species that comprise the seed mix and the percentage by mass of each.
- c) The grade of the seed or seed mix.
- d) The supplier's lot designation number corresponding to the Certificate of Seed Analysis.
- e) Mass in kilograms of the seed mix.
- f) The inoculant type, strain, and expiry date.

All seed and inoculant shall be stored in cool, dry locations until use. Inoculant is only required for seed mixes containing Crown Vetch or Birdsfoot Trefoil.

804.05.01.04 Permanent Seed Mixes

Permanent seed mixes shall be as specified in the Contract Documents and as shown in Table 1.

804.05.02 Annual Nurse Crop Seed

Nurse crop seed shall be either Fall Rye Grain or Winter Wheat Grain, unless otherwise approved by the Contract Administrator.

804.05.03 Fertilizer

Fertilizer shall comply with the provisions of the Canada Fertilizers Act and Regulations. Fertilizer shall be supplied in original factory sealed bags bearing the manufacturer's original label indicating mass and analysis. All fertilizer shall be in granular form being dry, free flowing, free from lumps, and with an analysis shown in Table 2.

804.05.04 Cover

804.05.04.01 Straw Mulch

Straw mulch shall be oat or wheat straw. Straw shall be supplied in bales, dry, and free of weeds and other foreign materials.

804.05.04.02 Straw Mulch Tackifiers

Organic straw mulch tackifiers may include wood and fibre paper mulch or guar and starch based tackifiers. Asphalt based tackifiers are not acceptable.

804.05.04.03 Hydraulic Mulch

Hydraulic mulch shall be capable of dispersing rapidly in water to form a homogeneous slurry and remain in such a state when agitated or mixed with other specified materials. When applied, hydraulic mulch shall be capable of forming a uniform, cohesive mat. Hydraulic mulch shall not inhibit growth or germination of the seed mix. Hydraulic mulch shall be dry, free of weeds and other foreign materials, and shall be supplied in factory sealed packages bearing the manufacturer's label indicating the product name and mass.

804.05.04.04 Bonded Fibre Matrix (BFM) and Fibre Reinforced Matrix (FRM)

BFM and FRM shall be a hydraulically applied, 100% biodegradable product, which after application is capable of adhering to the soil. In a dry state, BFM shall be comprised of not less than 70% by weight of long stranded wood fibres held together by organic or mineral bonding agents or both. The hydrated BFM shall form a viscous material that creates a high strength, porous, and erosion-resistant uniform, cohesive mat, when applied and dried. The bonding agent shall not dissolve or disperse upon re-wetting. BFM shall not inhibit the germination or growth of plant material.

804.05.04.05 Erosion Control Blanket (ECB)

ECB shall be of a consistent thickness with a 100% biodegradable even fibre distribution. The ECB shall be covered on top with a biodegradable and photodegradable plastic mesh. ECB may also be sewn together with cotton thread. ECB shall be supplied in a dry rolled mat protected with an outer waterproof wrap bearing the manufacturer's original label indicating product name and application instructions.

804.05.05 Erosion Control Blanket (ECB) Staples

ECB staples shall be u-shaped, constructed of wire with a diameter of at least 2.5 mm with legs at least 150 mm long and 25 mm apart.

804.05.06 Water

Water shall be free of any contaminants or impurities that would adversely affect the germination and growth of vegetation.

804.06 EQUIPMENT

804.06.01 Hydraulic Seeder and Mulcher

The hydraulic seeder and mulcher shall be capable of mixing the materials into homogeneous slurry and maintaining the slurry in a homogeneous state until it is applied. The discharge pumps and gun nozzles shall be capable of applying the materials uniformly over the specified area. A hose extension for the hydraulic seeder and mulcher shall be on site and available for use for areas outside of the range of the gun nozzle.

804.06.02 Straw Mulch Blower

The straw mulch blower shall be capable of separating straw from the bales without chopping it into short lengths and applying the straw mulch in a uniform, cohesive mat.

When tackifiers are used, the straw mulch blower shall be capable of applying straw mulch and tackifiers simultaneously. The straw mulch blower shall be equipped with a minimum of two nozzles located inside the end of the blower pipe to coat the straw with the tackifier. Crimping may also be used to secure the straw mulch.

804.06.03 Cyclone Spreader

The cyclone spreader shall be capable of distributing seed and fertilizer uniformly in a dry state.

804.07 CONSTRUCTION

804.07.01 Operational Constraints

The seeding operation shall not commence until the Contract Administrator is in receipt of the Certificate of Seed Analysis for the seed being applied.

The seeding operation shall not commence until the Contract Administrator has approved the surface preparation, layout of permanent seed mix locations, and different cover types.

Seed and cover application or re-application shall not be carried out under adverse weather conditions such as high wind or heavy rain or when field conditions are not conducive to seed germination such as frozen soil or soil covered with snow, ice, or standing water.

The Contractor shall maintain the site and control erosion until final acceptance of the seed and cover.

Seed or cover shall not come in contact with the foliage of any trees, shrubs, or other vegetation, except as specified in the Seeding subsection. Seed or cover shall not come in contact with waterbodies.

BFM or FRM shall be installed by a Contractor certified and trained by the manufacturer in the proper mixing and installation of the product. To ensure a suitable drying and curing period, BFM and FRM shall not be applied when rainfall is expected, during rainfall, or immediately after rainfall.

804.07.02 Surface Preparation for Seeding

The surface to be seeded shall be prepared not more than 7 Days prior to the seeding operation.

At the time of seeding, all surface areas designated for seeding shall have a fine-graded uniform surface and shall exhibit no evidence of erosion. The surface shall be uniformly cultivated to a minimum depth of 50 mm and shall not have surface stones greater than 25 mm in diameter, foreign material, and weeds or other unwanted vegetation.

804.07.03 Layout

The locations and limits of the different permanent seed mixes and different cover types as specified in the Contract Documents shall be staked out on the ground surface.

804.07.04 Seeding

804.07.04.01 Application Rates for Seed, Fertilizer, and Water

Application rates for primary seed, nurse crop seed, and fertilizer shall be as shown in Table 2.

804.07.04.02 Seed and Fertilizer Application

Seed and fertilizer shall be applied prior to the application of cover.

Seed, fertilizer, and water shall be thoroughly mixed in the hydraulic seeder and mulcher into a homogeneous water slurry. When thoroughly mixed, the water slurry shall be applied to the prepared earth areas by the nozzle sprayer or extension hose.

The Contractor shall ensure that the seeding equipment is calibrated to provide the coverage shown in Table 2. The Contractor shall ensure there is a uniform dispersal of the mixed material over the entire area designated for seeding and that the spray does not dislodge soil or cause erosion.

Seed and fertilizer may also be applied separately by a cyclone spreader. Seeding shall overlap the adjoining ground cover by 300 mm.

804.07.05 Cover Applications

All cover materials shall be applied as a separate operation immediately following the application of seed and fertilizer.

The Contractor shall ensure that the hydraulic seeder and mulcher are properly calibrated to provide the coverage as specified for each of the hydraulically applied cover materials.

804.07.05.01 Straw Mulch Application

Straw mulch shall be applied to form a uniform, cohesive mat over 100% of the seeded earth area. The straw mulch shall be applied to a minimum depth of 25 mm and a maximum depth of 50 mm measured at the time of application.

804.07.05.02 Hydraulic Mulch Application

Hydraulic mulch shall be applied at the rate of 2,000 kg of dry product per 10,000 m². Hydraulic mulch shall be thoroughly mixed with water into a homogenous slurry.

When thoroughly mixed, the hydraulic mulch slurry shall be applied to the seeded earth areas by nozzle sprayer or extension hose. The mixed material shall be evenly dispersed over the entire seeded earth area to form a uniform, cohesive mat. The spray shall not dislodge soil or cause erosion.

804.07.05.03 Bonded Fibre Matrix (BFM) and Fibre Reinforced Matrix (FRM) Application

BFM and FRM shall be applied at a minimum rate of 3,700 kg of dry product per 10,000 m². BFM or FRM shall be mixed with water in a hydraulic seeder and mulcher at a rate of 20-30 kg of dry product to 500-600 litres of water to form a homogeneous slurry.

When thoroughly mixed, the BFM or FRM slurry shall be applied to the seeded earth areas by nozzle sprayer or extension hose. The BFM or FRM slurry shall be evenly dispersed in successive applications from different directions over the seeded earth area to form a uniform, cohesive mat. The spray shall not dislodge soil or cause erosion.

804.07.05.04 Erosion Control Blanket (ECB) Application

(ECB) shall be placed and stapled into position according to the manufacturer's installation instructions over the entire designated surface area. Blankets shall be installed in direct contact with the ground surface to form a uniform, cohesive mat over the seeded earth area. The Contractor shall ensure that the ECB is anchored to the soil and that tenting of the ECB does not occur.

On slopes, the uppermost edge of the ECB shall be anchored in a 150 mm wide by 150 mm deep trench when the ECB cannot be extended and anchored over the crest of the slope. The trench shall be backfilled with earth and compacted.

804.07.06 Cleanup

When seed and cover materials are applied to the foliage of trees, shrubs, other susceptible plant material, or waterbodies, the Contractor shall immediately remove the seed and cover materials from the areas and wash the areas with clean water.

When seed and cover materials are applied to areas or objects other than those designated, the Contractor shall remove the seed and cover materials.

804.07.07 Management of Excess Material

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

804.07.08 Protection of Waterbodies and Waterbody Banks

Protection of waterbodies and waterbody banks shall be as specified in the Contract Documents.

804.08 QUALITY ASSURANCE

804.08.01 Performance Measure

The Certificate of Seed Analysis shall be reviewed by the Contract Administrator to ensure compliance with the values shown in Table 1.

All seeded areas shall be inspected by the Contract Administrator using the Seeding and Cover Quality Assurance Visual Inspection Field Guide to ensure compliance with this specification at 30, 60, and 90-Day periods following the seeding and Cover operation.

At the 30-Day inspection within the seeded area:

- a) The applied cover shall be visually intact and shall form a uniform, cohesive mat.
- b) Germination of the nurse crop shall be visually evident.

At the 60-Day inspection within the seeded area:

- a) The nurse crop shall be evident at mature height in an evenly dispersed, uniform cover.
- b) Germination of the specified permanent seed species shall be visually evident in an evenly dispersed uniform cover.
- c) There shall not be any significant bare areas, both in terms of quantity and size.
- d) Non-seeded, non-specified vegetation shall not exceed 20% of the seeded earth area.

At the 90-Day inspection within the seeded area:

- a) The specified permanent seed species shall be at an average height of 50 mm in an evenly dispersed, uniform cover.
- b) There shall not be any significant bare areas, both in terms of quantity and size.
- c) Non-seeded, non-specified vegetation shall not exceed 20% of the seeded earth area.

Inspections shall not be made during the winter dormant period or when site conditions prohibit a visual field inspection. The timing intervals between inspections shall be suspended during the winter dormant period shown in Table 3.

804.08.02 Failure to Meet Performance Measure

If the values in the Certificate of Seed Analysis for the seeds supplied do not meet the values for seed germination, seed purity, and weed seed content shown in Table 1, the seed lot shall not be approved for use on the Contract and the Contractor shall supply a new seed lot and a new Certificate of Seed Analysis for approval prior to seeding.

If the values in the Certificate of Seed Analysis for the seeds supplied do not meet the values for seed species composition shown in Table 1, the Contractor shall supply a legible, valid copy of the seed mixing sheet from the seed supplier for approval by the Contract Administrator prior to seeding.

If the completed work does not meet the performance measures of the 30-Day inspection, the Contract Administrator shall document the failed areas, notify the Contractor of those areas, and re-inspect at the 60-Day inspection.

If the completed work does not meet the performance measures of the 60-Day inspection, the Contract Administrator shall notify the Contractor in writing of the failed areas. The Contractor shall re-apply the specified material in accordance with this specification within 14 Days of receiving the notification. The Contract Administrator shall re-inspect the seeded area at the 90-Day inspection.

If the completed work does not meet the performance measures of the 90-Day inspection, the Contract Administrator shall notify the Contractor in writing of the failed areas. The Contractor shall re-apply the specified material in accordance with this specification within 14 Days of receiving the notification. The Contract Administrator shall re-inspect the seeded area 30 Days after re-application of material.

Inspections and re-application of material shall continue, as outlined in the 90-Day inspection clause above, until the seeded area has been accepted.

All replaced seed and cover shall be subject to the Quality Assurance section of this specification.

804.08.03 Dispute Resolution

Dispute resolution only applies to the germination and growth of the permanent seed mix species.

Disputes arising from the performance measure evaluation shall be settled through referee testing using an actual live seedling count of the specified permanent seed mix species within the seeded earth area.

An independent consultant with experience in herbaceous plant identification shall perform the referee testing. Both parties shall agree on the selection of the independent consultant and both parties shall be bound by the consultant's evaluation.

The actual count shall be based on minimum germination requirements and minimum levels of acceptability to meet industry standards and federal legislation governing the testing, inspection, quality, and sale of seed.

To determine the number of seeds per unit of weight, published standard industry lists shall be referenced. When these lists show a range in the number of seeds per unit of weight, the mid-range number shall be used. When there is a difference in the estimated number of seeds by weight from one industry standard list to another, the lower figure shall be used.

To determine the germination rate for each seed species, the number of seeds per unit of weight is factored by the minimum germination rate of 70% in accordance with the Canada Seeds Act. A further 25% reduction is allowed to account for variation in seeding application, seedbed quality, seedbed preparation, and area cover.

The Contractor and the Owner may agree to use a simplified analysis, when instead of counting each seedling of each individual seeded perennial species of the mix, only the total number of seedlings of the mix is counted. If the parties cannot agree to the simplified analysis, the default method is a seedling count of each seeded perennial species.

The field inspection to determine the number of live plant seedlings should only be performed after the 90-Day inspection and when the seedlings reach an identifiable and measurable size.

The sampling procedure should be randomized over an area that both parties agree is representative of the seeded Contract. The selection and evaluation process is as follows:

- a) Select a representative area from the average seeded areas, eliminating the thinnest and thickest growth areas from the analysis.
- b) Measure its length and width. Use a random numbers table to generate five sets of X and Y axis coordinates from the area.
- c) Each axis coordinate is a sampling point. A sampling plot, or quadrat, is set out in a 200 x 1,000 mm plot with the axis coordinate becoming the lower right-hand corner of each quadrat.
- d) Each quadrat is divided into 20 sub-sampling units, each being 100 x 100 mm.
- e) The sub-sampling units are numbered from 1 to 20.
- f) Using a random numbers table, two of the twenty sub-sampling units are randomly selected.
- g) Live seedlings of each individual seeded perennial species of the mix are counted in the selected sub-sampling units to determine actual plant densities.
- h) An average seedling density per seeded perennial species, expressed as the number of seedlings per square metre is generated for each sampling plot or quadrat, based on the data from the two selected sub-sampling units.
- i) The procedure is repeated for the four other sampling points.
- j) The average number of seedlings per square metre for each of the seeded perennial species generated from the five sampling points is evaluated against the minimum industry standard benchmark for the seeded mix.

If the results of the referee testing prove that the seed and cover is unacceptable in meeting the minimum industry standard for germination, the Contractor shall then re-apply seed and cover in accordance with this specification to all areas under dispute. In addition, the Contractor shall be responsible for all costs associated with the dispute resolution process.

If the results of the referee testing prove that the seed and cover is acceptable in meeting the minimum industry standard for germination, the Owner shall then be responsible for all costs associated with the dispute resolution process.

804.09 MEASUREMENT FOR PAYMENT

804.09.01 Actual Measurement

804.09.01.01 Seed and Mulch

Seeding and mulch measurement shall be in square metres following the contours of the ground without any allowance for overlap.

804.09.01.02 Seed and Erosion Control Blanket

Seeding and erosion control blanket measurement shall be in square metres following the contours of the ground without any allowance for overlap.

804.09.01.03 Seed and Bonded Fibre Matrix (BFM) or Fibre Reinforced Matrix (FRM)

Seed and BFM or RFM measurement shall be in square metres following the contours of the ground without any allowance for overlap.

804.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

804.10 BASIS OF PAYMENT

**804.10.01 Seed and Mulch - Item
Seed and Erosion Control Blanket - Item
Seed and Bonded Fibre Matrix or Fibre Reinforced Matrix - Item**

Payment at the Contract price for the above tender items shall be full compensation for all the labour, Equipment, and Material to do the work.

TABLE 1
Permanent Seed Mixes and Seed Certificate Analysis Values

Permanent Seed Mix	Grade Name	Minimum Seed Germination %	Minimum Seed Purity %	Maximum Weed Seed %	Seed Mix %	Seed Species Composition %
Standard Roadside Mix	Canada #1 Lawn Grass Seed Mixture	70	85	0.5		
Creeping Red Fescue: <i>Festuca rubra</i>					50	50 to 60
Kentucky Bluegrass: <i>Poa pratensis</i>					10	25 to 30
Perennial Ryegrass: <i>Lolium perenne</i>					35	12 to 18
White Clover: <i>Trifolium repens</i>					5	2 to 4
Crown Vetch Mix	Common #1 Forage Mixture	75	N/A	3.0		
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	3.0		
Creeping Red Fescue: <i>Festuca rubra</i>					66	62 to 70

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Permanent Seed Mix	Grade Name	Minimum Seed Germination %	Minimum Seed Purity %	Maximum Weed Seed %	Seed Mix %	Seed Species Composition %

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Birdsfoot Trefoil 'Leo': <i>Lotus corniculatus</i> 'Leo inoculated seed					34	30 to 38
Salt Tolerant Mix	Canada #1 Ground Cover Mixture	70	85	3.0		
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 25
Perennial Ryegrass: <i>Lolium perenne</i>					20	15 to 25
Hard Fescue: <i>Festuca trachyphylla</i>					10	10 to 15
Lowland Mix	Common #1 Forage Mixture	75	N/A	3.0		
Creeping Red Fescue: <i>Festuca rubra</i>					35	40 to 50
Brome Grass: <i>Bromus nerris</i>					25	20 to 30
Kentucky Bluegrass: <i>Poa pratensis</i>					10	10 to 20

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Permanent Seed Mix	Grade Name	Minimum Seed Germination %	Minimum Seed Purity %	Maximum Weed Seed %	Seed Mix %	Seed Species Composition %

Continues From Previous Page

Birdsfoot Trefoil 'Leo': <i>Lotus corniculatus</i> 'Leo' inoculated seed					5	3 to 7
White Clover: <i>Trifolium repens</i>					5	3 to 7
Perennial Ryegrass: <i>Lolium perenne</i>					20	3 to 7
Acidic Soil Mix	Common #1 Forage Mixture	75	N/A	3.0		
Birdsfoot Trefoil 'Leo', <i>Lotus corniculatus</i> 'Leo' inoculated seed					30	30 to 40
Red Top: <i>Agrostis gigantea</i>					10	20 to 30
Tall Fescue: <i>Festuca arundinacea</i>					15	15 to 20
Creeping Red Fescue: <i>Festuca rubra</i>					30	7 to 12
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

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Permanent Seed Mix	Grade Name	Minimum Seed Germination %	Minimum Seed Purity %	Maximum Weed Seed %	Seed Mix %	Seed Species Composition %

Continues From Previous Page

Northern Ontario Mix	Common #1 Forage Mixture	75	N/A	3.0		
Red Top: <i>Agrostis gigantea</i>					10	35 to 40
Timothy: <i>Phleum pratense</i>					10	10 to 20
Creeping Red Fescue: <i>Festuca rubra</i>					30	10 to 15
Birdsfoot Trefoil: <i>Lotus corniculatus</i> 'Leo" inoculated seed					5	6 to 10
Alsike Clover: <i>Trifolium hybridum</i>					3	3 to 7
White Clover: <i>Trifolium repens</i>					2	3 to 7
Bromegrass: <i>Bromus nerrer</i>					20	1 to 5
Hard Fescue: <i>Festuca trachyphylla</i>					10	1 to 5
Meadow Fescue: <i>Festuca pratensis</i>					10	1 to 5

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	130	350	-	-	60
Crown Vetch Mix	100	350	250	-	60
Birdsfoot Trefoil Mix	100	350	250	-	60
Salt Tolerant Mix	130	350	-	-	60
Lowland Mix	130	350	-	-	60
Acidic Soil Mix	130	350	200	200	60
Old Field Mix	100	350	-	-	60

TABLE 3
Winter Dormant Period

SOUTHWESTERN ONTARIO	SOUTHERN ONTARIO	NORTHERN ONTARIO
That area of Ontario south of a line joining Grand Bend and Clarkson.	That area of Ontario between the northern and southern boundaries of Southwestern Ontario and Northern Ontario respectively.	That area of Ontario north of a line joining Waubesa, Severn Bridge, Bancroft, and Ottawa.
November 15 to April 15 inclusive	November 1 to April 30 inclusive	October 15 to May 15 inclusive

Appendix 804-A, November 2014
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

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

Designer Action/Considerations

The following should be specified in the Contract Documents:

- Permanent seed mixes. (804.05.01.04)

The designer may select the appropriate seed mix and cover type application from Tables A-1 and A-2 included in this appendix. The designer may propose new site specific seed mixes to suit existing conditions that require a different seed than those specified.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

**APPENDIX TABLE A-1
Permanent Seeding Mix Types**

Permanent Seed Mixes	Seed Mix Attributes	Selection Criteria
Standard Roadside Mix	A tested mix of hardy roadside perennial grasses that have performed well in highway situations.	This mix should be the default seed mix for most roadside seeding work.
Crown Vetch Mix	A blend of a hardy legume and a hardy turfgrass. The turfgrass provides control and top growth until the Crown Vetch plants grow and develop after several seasons. Crown Vetch produces a mass of purple flowers in season and is a vigorous ground cover.	This mix is primarily used to revegetate slope areas when erosion and soil fertility may be a problem. There have been some concerns over its ability to spread and crowd out indigenous growth and its non-native status.
Birdsfoot Trefoil Mix	A blend of another hardy legume and a hardy turfgrass. Very similar growth characteristics to the Crown Vetch mix, except a little slower growing, less vigorous, and Trefoil has masses of yellow flowers in season.	As with Crown Vetch, this mix is primarily used to revegetate slope areas when erosion and soil fertility may be a problem. It is hardier in the north than Crown Vetch and is not as aggressive in growth and habit.
Salt Tolerant Mix	The salt tolerant mix is a blend mixture of several turfgrass species with a proven resistance to salt.	The salt tolerance mix should be specified in areas such as medians, shoulder strips, and shoulder ditches, when salt is thought to be in heavier concentrations.
Lowland Mix	The lowland mix was developed with several species of turfgrasses that grow well in low-lying wet areas.	The lowland mix should be specified along waterbody edges in low-lying areas when light seasonal flooding is a possibility.
Acidic Soil Mix	The acidic soil mix was developed to provide adequate vegetative cover on areas of low fertility and high acidity.	The acidic soil mix should be used in areas of low fertility, medium to high acidity, and in the northern areas of the province.
Northern Ontario Mix	This mix is designed to suit the limited topsoil conditions and acidity of Northern Ontario sites.	Old field should be selected when there will be fallow areas left alone with little or no maintenance, no mowing, and the area will be required to be self-sustaining. More suitable in rural areas than urban or suburban.

**APPENDIX TABLE A-2
Seeding Cover Application Types**

Cover Application Types	Cover Type Attributes	Selection Criteria
Straw	Chopped straw is applied to the seeded area via a straw mulch blower and is coated with a tackifier or crimped to hold it together. A time-tested method of providing cover and protection for germinating seedlings, as well as short-term erosion control.	One of the default cover types. Straw has the advantage of being relatively cheap and providing good coverage. Straw cover application requires another piece of equipment and a labour intensive second application to properly apply the cover material.
Hydraulic Mulch	Hydraulic mulch is a processed fibre of wood, straw, cotton, cellulose pulp, or any combination of these materials. Hydraulic mulches provide a uniform absorptive mat that allows moisture to penetrate into the underlying soil, while providing cover for the germinating seed.	Hydraulic mulch is the other default mulch. It has the advantage of being easy to apply, using the same equipment when applying seed and fertilizer. It is low-cost and low-labour. Hydraulic mulch does not give the same degree of protection to the germinating grass as straw does. During extremes of temperature and moisture, it will not perform as well as straw or other higher levels of erosion control.
Erosion Control Blanket (ECB)	ECBs are a family of products that are supplied in rolls. They are unrolled over the seeded earth area and stapled in place. ECBs provide a higher level of erosion control and protection for germinating seedlings. ECBs are machine woven mats with a variety of materials sandwiched between the two woven layers. Materials can be wood, coco or cotton fibre, straw, or any combination depending upon manufacturer.	ECBs should be specified in the contract preparation stage and not during construction. ECBs are specified on a project when erosion of soil slopes or soil ditches is expected to be a problem. ECBs have an advantage over hydraulic mulch in that the blanket is firmly attached to the underlying soil by staples, it is longer lasting, and provides a superior growth medium for seedlings. It is more expensive and improper installation can result in poor end results leading to surface erosion.
Bonded Fibre Matrix (BFM)	BFM is a hydraulically applied product made of wood, cotton, or cellulose pulp fibres. The fibres are bonded together by various means including mineral bonding agents or organic tackifiers. When applied, the BFM forms a viscous material that upon drying creates a high strength, porous, and erosion resistant mat.	BFMs are applied like hydraulic mulches and have a great similarity to hydraulic mulches, except BFMs have greater erosion resistance and create a thicker, firmer mat. BFMs should be specified when erosion of soil slopes or soil ditches is expected to be a problem and when hydraulic seeders can get access. BFMs are specified in the design stage and have also been substituted for ECBs during construction, although usually at the Contractor's request.
Fibre Reinforced Matrix (FRM)	FRM is a hydraulically applied product made of pasteurized wood fibers, dispersible synthetic fibers, and soil-bonding agents. When applied, the FRM forms a viscous material that dries quickly and locks up within one hour. Upon drying the product provides increased flexibility and loft for impact resistance, air circulation, and moisture retention that promotes seed germination and plant growth.	FRMs are applied like hydraulic mulches and have a great similarity to hydraulic mulches, except differ from BFMs in that they cure within two hours, have superior cover factor and vegetation establishment. The functional longevity is up to 18 months. Due to the thickness, the product provides superior terrain protection, even during hard rains. This product can be used for any slopes, including 1H:1V.



CONSTRUCTION SPECIFICATION FOR DEEP FOUNDATIONS

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903.01 SCOPE

This specification covers the requirements for the supply and installation of deep foundation units.

903.01.01 Specification Significance and Use

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

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

905.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

905.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 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.

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.

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

Milestone inspections shall be performed by the Contract Administrator for the following interim inspections of the work for caisson piles:

- a) Excavation.
- b) Steel reinforcement installation.
- c) Placing of concrete.

Written permission to proceed shall be received from the Contract Administrator prior to commencement of the next operation.

903.04.02.04.03 Displacement Caisson Piles

The following shall be submitted to the Contract Administrator as least 14 Days prior to construction, for information purposes only:

- a) A schedule of work identifying time and sequence of activities.
- b) Type of equipment, anvil, helmet, and hammer details, including the hammer energy assumed by the Contractor, stated potential energy (rated energy) of the hammer, operating efficiency, maximum stroke or drop, and weight of the ram.
- c) Details of procedures used for installation of displacement caisson piles, including detailed procedures for liner installation and withdrawal.
- d) Method of maintaining the steel reinforcement cages in position in the pile.
- e) Details of procedure to be used for monitoring pile installation.
- f) When load testing is specified in the Contract Documents, details of the full-scale test, including site preparation, and the details of the load application, components, equipment, testing apparatus, and method of monitoring.

903.04.02.04.04 Steel Reinforcement Cages

Working Drawings showing the fabrication details of the steel reinforcement cages, including the lifting points and lifting lugs, shall be submitted to the Contract Administrator at least 14 days prior to fabrication, for information purposes only.

903.04.02.05 Review of Splice Test Results and Permission to Proceed

Upon completion of the testing of the splices, the Contract Administrator shall review all test results to verify that all welds were done according to the welding procedures and Contract Documents and issue the Contractor written permission to proceed with the work.

903.05 MATERIALS

903.05.01 Wooden Piles

Wooden piles shall be according to 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. Admixtures may be used to prevent arching of concrete during liner withdrawal and to prevent setting of concrete until after the liner is withdrawn.

903.05.07 Precast Concrete Piles

The production of precast reinforced concrete piles shall be according to OPSS 904, OPSS 905, and OPSS 909.

Steel reinforcement shall be placed such that direct loading during the ram stroke shall not occur.

Lifting anchors shall be at least 25 mm clear from reinforcement or prestressing steel in the pile.

Concrete in precast reinforced concrete piles shall be according to OPSS 1350 and have a nominal minimum 28-Day compressive strength of 45 MPa.

Concrete for precast reinforced concrete piles shall be cured according to OPSS 904.

Concrete for precast reinforced concrete piles shall be placed in smooth mortar-tight forms that are supported to prevent excessive deformation or settlement during placing or curing.

Unformed surfaces shall be finished smooth.

When removed from the form, the pile shall present true, smooth, even surfaces free from honeycombs and voids. The pile shall be straight so that a line stretched from butt to tip on any face shall not be more than 25 mm from the face of the pile at any point.

Each precast reinforced concrete pile shall have the date of manufacture (i.e., yyyy-mm-dd) inscribed on it.

903.05.08 Slurry

903.05.08.01 Solids

Bentonite and polymers shall be according to API Spec 13A.

903.05.08.02 Water

Water shall be according to OPSS 1302.

903.05.08.03 Slurry Composition

The slurry shall consist of a stable colloidal suspension of pulverized solids or polymers thoroughly mixed with water. The density, viscosity, sand content, and pH of the slurry being used during excavation shall be according to API RP 13B-1.

903.06 EQUIPMENT

903.06.01 Hammers

Hammers shall be capable of installing the piles, casings, and liners to the depth or resistance specified in the Contract Documents, without damage to the portions that are not cut off.

The hammer used to chisel the rock point into the rock shall be capable of delivering a controlled blow in 10% increments ranging in energy from zero to the maximum hammer energy.

For precast reinforced concrete piles, the heaviest hammer practicable shall be employed and the stroke limited so as not to damage the piles. When choosing the size of the hammer, consideration shall be given to whether the pile is to be driven to a resistance or to a given depth.

903.06.02 Helmets and Striker Plates

The head of steel piles shall be protected by a striker plate or a helmet. Helmets shall have adequate and suitable cushioning material. Helmets and striker plates shall distribute the blow of the hammer evenly throughout the cross-section of the pile head.

903.06.03 Leads

Pile driver leads shall be built to afford freedom of movement for the hammer and shall be held in position at the top and bottom by guys, stiff braces, or other approved means to ensure support of the pile, casing, or liner while it is being driven. Swinging leads shall not be permitted.

Batter piles, casings, or liners shall be driven with leads aligned parallel to the axis of the pile, casing, or liner. The leads shall be equipped with a fixed, rigid, adjustable kicker.

903.06.04 Followers

When use of followers are specified in the Contract Documents, followers shall be of type, size, shape, length, and weight as to permit driving the pile, casing, or liner at the location and to the required depth or ultimate resistance specified in the Contract Documents. The follower shall be provided with a socket or hood carefully fitted to the top of the pile, casing, or liner to minimize loss of energy and to prevent damage to the pile, casing, or liner, and shall have sufficient rigidity to prevent "whip" during driving.

When followers are permitted, an identical follower shall be used when the set is being determined.

903.07 CONSTRUCTION

903.07.01 Transporting, Storing, and Handling Piles, Casings, Liners, and Reinforcing Steel Reinforcement Cages

903.07.01.01 General

Piles, casings, liners, and steel reinforcement shall be transported, stored, and handled in such a manner that damage is prevented and the strength of the components is not affected by deterioration or deformation.

Components shall be lifted and placed using appropriate lifting equipment, temporary bracing, guys, or

stiffening devices so that the components are at no time overloaded, unstable, or unsafe.

Material shall be supported to prevent unequal settlement when stacked.

903.07.01.02 Wooden Piles

Canthooks, dogs, pile pulls, or use of other lifting methods that might damage the integrity of the pressure treated surface shall not be used. Cuts or breaks in the surface of treated piling shall be given three brush coats of hot creosote oil. Bolt holes shall be treated with three applications of hot creosote oil applied with a bolt hole treater.

903.07.01.03 Handling Holes in Steel Piles

Unless otherwise approved by the Contract Administrator, holes shall only be made in the portion of the pile to be cut off or in the portion of the pile to be encased in concrete.

When other holes are approved to be cut in a pile they shall be covered by splice plates placed on both sides of the section. The thickness and the mechanical properties of the plate material shall be at least equivalent to the pile material.

903.07.01.04 Precast Reinforced Concrete Piles

Precast concrete piles shall be handled only from the designated lifting points.

When lifting or transporting precast reinforced concrete piles lift anchors, slings, or other approved means shall be used. Care shall be taken when lifting and transporting to avoid any overstressing of the pile or cracking of the concrete.

Precast reinforced concrete piles shall be so handled to avoid breaking or chipping their edges.

Lift anchors shall be removed and the holes filled with a non-shrink grout or epoxy installed according to the manufacturer's recommendations.

903.07.01.05 Caisson Casings and Liners

Casings and liners shall be handled and stored in such a manner to avoid damage or distortion to them. The casings and liners shall be maintained circular within $\pm 2\%$ of the casing or liner diameter.

903.07.02 Driven Piles

903.07.02.01 Pile Driving Requirements and Restrictions

Piles shall not be driven until embankment work or excavation work has been completed to the underside of the footing. When driving of the piles is completed, all material between the piles shall be removed to the correct elevation and any holes or voids created shall be filled to the correct elevation with compacted material approved by the Contract Administrator.

Piles shall be installed at the locations specified in the Contract Documents and to the set or depth specified without being damaged. Damage to the pile, casing, or liner during driving shall be prevented by limiting the drop or energy and number of blows of the hammer. The hammer, helmet, cap block, striker plate, and pile shall be coaxial and shall sit squarely upon each other.

A shorter stroke shall be used and proper precaution shall be taken when there is a danger of damaging or over driving the piles, casing, or liners under conditions such as:

- a) In the early stages of driving a long pile where a hard layer near the ground surface has to be penetrated.

- b) Where there is very soft material of a considerable depth and a large penetration is achieved at each hammer blow.
- c) Where it is anticipated the pile shall meet refusal on rock or other impenetrable soil.
- d) When piles are driven onto sloping bedrock.

Damage to adjacent structures, Utilities, and fresh concrete shall be prevented during pile installation. Piles shall not be driven within a radius of 8 m of concrete that has been in place for less than 72 hours. Piles shall not be driven within a radius of 15 m of concrete that has been in place for less than 72 hours without the approval of the Contract Administrator.

The tops of all piles shall be either square to the longitudinal axis of the pile or horizontal as indicated in the Contract Documents.

Piles shall not be forced into their proper position by the use of excessive manipulation. Pile damage due to excessive driving shall be avoided.

903.07.02.02 Driving Shoes and Rock Points

Driving shoes and rock points shall be installed in locations specified in the Contract Documents.

Driving shoes shall be welded in accordance with the Contract Documents.

When driving shoes are specified in the Contract Documents, the Titus H bearing pile point, standard model, may be substituted for the driving shoes.

When Oslo points are specified in the Contract Documents, the Titus H bearing pile point, rock injector model, may be substituted for the pile points.

Where proprietary driving shoes are used, they shall be welded or otherwise attached to the driven piles according to the manufacturer's specifications.

903.07.02.03 Splicing

903.07.02.03.01 General

Any damaged material shall be cut-off prior to splicing.

903.07.02.03.02 Wooden Piles

Wooden piles shall not be spliced.

903.07.02.03.03 H-Piles, Tube Piles, and Sheet Piles

Welding shall be according to CSA W59 and shall be done by a qualified welder employed by a firm certified according to CSA W47.1, Division 1 or Division 2.1.

Steel H-piles and steel tube piles may be spliced providing 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.

903.07.02.07.02 Driving to a Specified Elevation

Piles shall be driven to an elevation specified in the Contract Documents. Driving piles to other elevations shall only be done when approved in writing by the Contract Administrator.

903.07.02.07.03 Driving to a Specified Ultimate Resistance

903.07.02.07.03.01 General

The Contract Administrator shall establish the reference set used to determine ultimate resistance and measure and record the set for individual pile acceptance.

The set and rebound measurements shall be obtained by the Contract Administrator. The Contract Administrator shall determine the measured ultimate resistance and verify that the design ultimate resistance has been achieved.

903.07.02.07.03.02 Driving to a Set

The founding elevation shall be established by driving to a set determined in accordance with the dynamic formula specified in the Contract Documents or by the application of the wave equation analysis procedure that verifies the pile resistance. This set shall be established on the first pile of every ten piles driven in a pile group.

The other piles shall be controlled by the pile penetration rate in blows per millimetre that correlates to the set.

When new conditions, such as change in hammer size, change in pile size, or change in soil material occur, new sets shall be determined.

903.07.02.07.03.03 Driving to Bedrock

When driving piles to bedrock, the pile shall be adequately seated on bedrock without damaging the pile.

Where rock points are used, the rock points shall penetrate into the rock. Piles driven using rock points shall be driven to ensure adequate seating on the bedrock without damaging the pile.

Driving of piles on sloping bedrock shall be stopped when initial contact is made with the bedrock. The bedrock elevation shall be recorded. Driving shall then continue, commencing with energy of 10% of the maximum energy of the hammer. The pile shall be driven in sets of 20 blows at this energy until no penetration is observed. Twenty additional blows shall be applied, and, if no penetration is observed, the energy shall be increased by an additional 10% and the above procedure repeated.

Driving shall continue with these stepped increases in energy and with the same series of blows as described above, until the pile has been seated on the bedrock.

If unrealistic excessive penetration per blow is observed, driving shall be stopped and this excessive penetration immediately reported to the Contract Administrator.

The Contract Administrator shall determine when the hammer energy can be increased and when the driving is complete for each pile.

903.07.02.07.04 Wave Equation Analysis

When requested by the Contract Administrator, all equipment, material, and personnel shall be supplied to conduct the wave equation analysis procedure. The Contract Administrator shall review the results of the analysis.

903.07.02.07.05 Hammer Performance

When requested by the Contract Administrator, the hammer performance using the pile driving analyzer or other approved equivalent shall be verified in the presence of the Contract Administrator. Hammer performance shall be verified to ensure that the actual potential energy (rated energy) is not less than 90% of the stated potential energy. All instrumentation, access, and assistance for the testing and monitoring as directed by the Contract Administrator shall be provided.

903.07.02.07.06 Retapping Tests on Piles

In each pile group, 10% of the piles rounded up to the next whole number, but no fewer than two piles, shall be retapped no sooner than 24 hours after installation of the individual pile to confirm that the ultimate axial resistance has been sustained.

Retapping of piles driven to bedrock is not required.

903.07.02.07.07 Retapping and Redriving Piles

When the retapping tests indicate that the ultimate axial resistance has not been achieved on any one pile, all piles in the group shall be retapped.

Where the retapping reveals that the ultimate axial resistance of the piles has not been achieved, the piles that have not achieved the ultimate axial resistance shall be redriven to the specified resistance.

Where piles have risen, the piles shall be redriven to the original depth.

903.07.02.08 Jetting

Jetting shall be carried out in such a manner that the resistance of the piles already in place and the safety of adjacent structures shall not be impaired. Jetting shall be stopped at least 1 m above the final expected pile-tip elevation and at least 1 m above the tip elevation of any piles previously driven within 2 m of the jet. Where piles are to be end bearing on rock, jetting may be carried to the rock surface.

The driving and jetting of precast reinforced concrete piles shall not be carried out simultaneously.

903.07.03 Caisson Piles

903.07.03.01 General

Caissons shall be constructed as specified in the Contract Documents.

The final bearing elevation shall be as specified in the Contract Documents or as determined by the Contract Administrator. When permanent casings are not specified, the caisson shall be constructed in a drilled hole with or without the use of a temporary liner or slurry as determined by the Contractor.

903.07.03.02 Excavation

903.07.03.02.01 General

Sidewall stability shall be maintained throughout the excavation and concrete placement operation. Soil cave-in into the excavation hole shall be prevented.

The bottom of the excavation shall be cleaned before the start of concrete placement.

Excavation methods shall be such that the sides and bottom of the hole are straight and free of loose material that might prevent intimate contact of the concrete with undisturbed soil or bedrock.

Except when founded on sloping rock, the caisson bottom shall be level. On sloping rock, the caisson bottom may be stepped, with each step not greater than $\frac{1}{4}$ 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 Contract Administrator.

The reinforcement shall not be displaced or distorted during the construction of the caisson.

Arching of concrete during casing withdrawal shall be prevented.

903.07.03.07.02 Concrete Placed in the Dry

The concrete may be placed free fall provided the fall is vertically down the centre of the opening and transverse ties, spacers or other objects do not impede the free fall. In the event of interference with the concrete free fall, an elephant trunk or other means shall be used to prevent concrete segregation.

Concrete shall be placed in a continuous operation from the bottom to the top of the caisson or, where columns are cast integral with the caisson, to the elevation of the bottom of the column steel reinforcement cage. The concrete shall be vibrated for the last 1.5 m of the pour.

903.07.03.07.03 Concrete Placed Under Water or Under Slurry

Tremie or pumped concrete shall be carried out in one continuous operation. The tremie or pumping operation shall be a continuous flow of concrete that prevents the inflow of water or slurry.

Where tremie concrete is to be placed in a caisson under water, the Contractor shall maintain an adequate

head of water within the excavations to prevent the inflow of water through the base or walls of the caisson as the concrete is being placed.

Where tremie is placed under slurry, the caisson shall be filled with concrete entirely by tremie and the method of deposition shall not be changed part way up the caisson.

When concrete placement is not started within 6 hours of acceptance of the excavation, the excavation shall be redrilled, cleaned, and the slurry tested before concrete placement commences.

903.07.03.07.04 Withdrawal of Liners

Arching of concrete during withdrawal of the liner shall be prevented.

During withdrawal, the bottom of the liner shall have a minimum embedment into the concrete being placed and a sufficient head of concrete shall be maintained above the bottom of the liner at all times to prevent intrusion of soil and water into the hole.

During withdrawal, upward or downward movement of the steel reinforcement shall be monitored. Upward or downward movement shall be restricted to 150 mm.

A theoretical concrete level shall be calculated based on the quantity of concrete placed and the caisson dimensions, and this theoretical level shall be compared to the actual level of concrete in the caisson to provide a check for possible separation of shaft concrete during liner withdrawal.

903.07.03.07.05 Founding Elevation

The final founding elevation shall be as specified in the Contract Documents or an elevation approved in writing by the Contract Administrator. When casings are not specified in the Contract Documents, the caisson shall be constructed in a drilled hole with or without the use of a liner or slurry as determined by the Contractor.

Except when founded on sloping unweathered bedrock, the caisson bottom shall be level. On sloping unweathered bedrock, the caisson bottom may be stepped, with each step not greater than one quarter the diameter of bearing area.

The bearing area of the caisson pile shall be approved by the Contract Administrator prior to placing concrete.

903.07.04 Displacement Caisson Piles

Work shall be carried out in accordance with the displacement caisson pile suppliers' installation procedures. A permanent liner shall be used when specified in the Contract Documents.

The sequence of installation shall be such as to prevent damage to any recently completed piles.

The pile shall not be founded above or below the specified pile tip elevation without approval in writing from the Contract Administrator.

903.07.05 Tolerances

903.07.05.01 Driven Piles

- a) Cut-off elevation ± 25 mm.
- b) Deviation from vertical not more than 1H:50V, except in the case of a pile cap or footing supporting only a single row of piles the deviation shall not be more than 1H:75V in the direction of the span.
- c) The deviation from the specified inclination for battered piles shall not exceed 1H:25V.

- d) The centre of the pile at the junction with the pile cap shall be within 150 mm measured horizontally of that specified except in the case of a pile cap or footing supported on a single row of piles the deviation shall not be more than 75 mm measured horizontally in the direction of the span.

903.07.05.02 Caissons and Displacement Caisson Piles

- a) Cut-off elevation ± 25 mm.
- b) Horizontal location at cut-off not more than 5% of shaft diameter or 75 mm, whichever is less.
- c) Vertical alignment not more than 2% of the caisson length from vertical for vertical caissons, or 2% of the caisson length from the specified inclination for battered caissons.

903.07.06 Load Test

When a load test is specified in the Contract Documents, the testing shall be according to ASTM 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. All records and results of the pile load test shall be submitted to the Contract Administrator.

All necessary personnel, equipment, and material to make adjustments during the tests shall be provided and at least one skilled worker shall be present for the complete duration of each test. This worker shall have demonstrated experience in load testing of piles.

The following shall be provided for the duration of all testing:

- a) A level dry working area at the test location
- b) An adequate enclosure sufficient to provide complete protection from adverse weather conditions
- c) All temporary work required to obtain access to the site for the personnel, equipment, and materials.

Upon completion of the tests, the site shall be cleared and restored to the satisfaction of the Contract Administrator. Piles that are not part of the finished work shall be cut off 1.2 m below ground level or 0.6 m below stream bed level. Any resulting void shall be backfilled with suitable fill material.

903.07.07 Repair of Welds

Any section of weld that does not meet the requirements of the Contract Documents shall be removed and rewelded.

903.08 Quality Assurance

903.08.01 Inspection and Testing of Welds

903.08.01.01 Qualifications of Companies and Individuals

The Contract Administrator shall have an independent testing company carry out the non-destructive testing of welds. The independent testing company shall be certified by the Canadian Welding Bureau to the requirements of CSA W178.1 for bridge structures by radiographic or ultrasonic test methods.

Testing shall be done by a non-destructive testing technician employed by the independent testing company. The non-destructive testing technician shall have documented evidence of training and professional knowledge, skill, and experience in non-destructive testing of structural steel welds and material and have a valid certificate showing qualification to a Level II or III according to CAN/CGSB 48.9712 and the Canadian Welding Bureau for the non-destructive testing specified.

A welding inspector, employed by an independent testing company, shall perform visual inspection. The welding inspector shall have documented evidence of training, professional knowledge, skill and experience in visual inspection of structural steel welds and material, and have a valid certificate showing qualification to a Level II or III according to CSA W178.2.

903.08.01.02 Visual Inspection of Welds

A representative sample of not less than 30% of the welds, as determined by the Contract Administrator, shall be visually inspected for conformance to the requirements of CSA W59, the Contract Documents, and the Working Drawings.

903.08.01.03 Non-Destructive Testing of Welds

The non-destructive testing technician shall carry out radiographic or ultrasonic testing using procedures according to CSA W59.

Ultrasonic or radiographic testing shall be carried out on the entire length of selected splice welds chosen at random by the Contract Administrator or the welding inspector assigned to carry out visual inspection. Selection shall be based on the following criteria:

- a) For pile groups other than at integral abutments, 10% of the splice welds, rounded to the next highest number, but no fewer than two.
- b) For pile groups at integral abutments, 10% of the splice welds, rounded to the next highest number, but no fewer than two of when the welds are below 6 m of the pile cut-off elevation.
- c) For pile groups at integral abutments, all splice welds within 6 m of the pile cut-off elevation.

903.08.01.04 Repaired Welds

All welds that have been repaired shall be visually inspected and shall undergo non-destructive testing.

903.08.02 Visual Inspection Reports and Non-Destructive Test Reports

Within 7 Days of completion of the inspection and testing, the welding inspection company shall submit 2 copies of all inspection and testing reports to the Contract Administrator, for information purposes only.

903.09 MEASUREMENT FOR PAYMENT

903.09.01 Actual Measurement

903.09.01.01 H-Piles, Tube Piles, Wooden Piles, and Precast Reinforced Concrete Piles

Measurement of piles shall be by length in metres of the piling left in place after cut-off.

903.09.01.02 Sheet Piles

Measurement of sheet piles shall be by area in square metres based on the driving lines specified and the length of piling left in place after cut-off.

903.09.01.03 Driving Shoes

For measurement purposes, a count shall be made of the number of drive shoes used.

903.09.01.04 Rock Points

For measurement purposes, a count shall be made of the number of rock points used.

903.09.01.05 Caissons and Displacement Caisson Piles

Measurement of caissons and displacement caisson piles shall be by length in metres of the depth along the centreline between the approved bearing surface at the bottom and the specified elevation at the top.

903.09.01.06 Retapping Piles

For measurement purposes, a count shall be made of the number of piles retapped above and beyond the minimum number described in the Retapping Tests on Piles clause.

Piles retapped as part of the minimum number required for the retapping tests described in the Retapping Tests on Piles clause shall not be measured for payment.

903.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

903.10 BASIS FOR PAYMENT

**903.10.01 Supply Equipment for Installing Driven Piles - Item
Supply Equipment for Installing Caisson Piles - Item
Supply Equipment for Installing Displacement Caisson Piles - Item**

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material required to do the work.

For payment purposes, 50% of the work under this item is completed when the satisfactory performance of the equipment has been demonstrated to the Contract Administrator by the installation of 1% of piles. The remaining 50% shall be paid on the satisfactory completion of the installation of piles.

When the hammer performance is requested to be verified, such verification shall be completed at no extra cost to the Owner when the energy delivered is less than 90% of the stated potential energy (rated energy) specified in the submission.

When the energy is equal to or greater than 90% of the stated potential energy stated in the required submission, the cost verifying the hammer performance shall be paid as Extra Work.

**903.10.02 H-Piles - Item
Tube Piles - Item
Precast Concrete Piles - Item
Wood Piles - Item
Displacement Caisson Piles - Item
Caisson Piles - Item
Driving Shoes - Item
Rock Points - Item
Sheet Piles - Item
Load Test - Item**

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Payment for redriving piles shall be at the Contract price for the applicable tender item above.

When the Contractor substitutes driving shoes or Oslo points with Titus H bearing pile points, the cost of such substitutions shall be at no extra cost to the Owner.

903.10.03 Retapping Piles - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

Retapping the minimum specified number of piles for retapping tests shall include all labour, Equipment, and Material to do the work and shall be included in the Contract price for the appropriate pile tender item.

Where additional retapping is required, payment shall be made based on the ratio of the number of piles retapped in a pile group above the minimum requirement, up to the total number of piles in that pile group, times the tender price for retapping all piles for that pile group.

Appendix 903-A, 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

The designer should specify the following in the Contract Documents:

- Load testing of driven piles. (903.04.02.04.01 g))
- Load testing of caisson piles. (903.04.02.04.02 j))
- Load testing of displacement caisson piles. (903.04.02.04.03 f))
- Welding. (903.04.02.06)
- Rock points and driving shoes. (903.05.03)
- Depth or resistance of piles, casings, and liners. (903.06.01)
- Type, size, shape, length, and weight of followers for piles, casings or liners. (903.06.04)
- Driven pile location and set or depth. (903.07.02.01)
- Driven pile cut off details. (903.07.02.01)
- Driven pile location and welding of driving shoes and location of rock points. (903.07.02.02)
- Splicing of precast reinforced concrete piles. (903.07.02.03.04)
- Cut off elevation of driven piles. (903.07.02.05.01)
- Driven pile elevation. (903.07.02.07.02)
- Dynamic formula for determining driving set for piles. (903.07.02.07.03.02)
- Caisson construction and elevation. (903.07.03.01)
- Steel reinforcement welding and splices. (903.07.03.06)
- Founding elevation of caisson piles. (903.07.03.07.05)
- Casing for caisson piles. (903.07.03.07.05)
- Displacement caisson pile permanent liner. (903.07.04)
- Load test for piles. (903.07.06)
- Visual inspection of welds. (903.07.08.01.02)

Appendix 903-A

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 3000.100	Foundation, Piles, Steel H-Pile, Driving Shoe
OPSD 3000.150	Foundation, Piles, Steel H-Pile, Splice
OPSD 3000.201	Foundation, Piles, Steel HP 310 Oslo Point
OPSD 3001.100	Foundation, Piles, Steel Tube Piles, Driving Shoe
OPSD 3001.150	Foundation, Piles, Steel Tube Piles, Splice
OPSD 3002.200	Foundation, Piles, Steel Sheet Piles, Anchorage
OPSD 3003.100	Foundation, Piles, Wood, Driving Shoe
OPSD 3003.150	Foundation, Piles, Wood, Pile Head Protection



CONSTRUCTION SPECIFICATION FOR CONCRETE STRUCTURES

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904.01	SCOPE

This specification covers the requirements for the construction of concrete structures.

904.01.01 Specification Significance and Use

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

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

904.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

904.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 501	Compacting
OPSS 905	Concrete Reinforcement
OPSS 908	Metal Traffic Barriers and Metal Railings for Structures
OPSS 919	Formwork and Falsework
OPSS 920	Deck Joint Assemblies, Waterstops, Joint Fillers, Joint Seals and Joint Sealing Compounds - Structures
OPSS 928	Structure Rehabilitation - Concrete Removal
OPSS 929	Abrasive Blast Cleaning - Concrete Construction
OPSS 930	Structure Rehabilitation - Concrete Patches and Overlays
OPSS 932	Crack Repair - Concrete

Ontario Provincial Standard Specifications, Material

OPSS 1002	Aggregates - Concrete
OPSS 1202	Bearings - Elastomeric Plain and Steel Laminated
OPSS 1301	Cementing Materials
OPSS 1302	Water
OPSS 1315	White Pigmented Curing Compounds for Concrete
OPSS 1350	Concrete - Materials and Production

Ontario Ministry of Transportation Publications

Laboratory Testing Manual:

- LS-413 Method of Test for Non-Volatile Content of Chemical Admixtures, Latex Admixtures and Curing Compounds
- LS-414 Method of Test for Relative Density of Chemical Admixtures, Air Entraining Admixtures, Latex Admixtures and Curing Compounds
- LS-416 Method of Test for Settling Rate - Curing Compound

ASTM International

- C 171-92 Sheet Materials for Curing Concrete

American Association of State Highway and Transportation Officials (AASHTO)

- M182-89 Standard Specification for Burlap Cloth made from Jute or Kenaf

904.03 DEFINITIONS

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

Bridge means a structure that is greater than 3 m in span that provides a roadway, carriageway, or walkway for the passage of vehicles or pedestrians or both across an obstruction or gap or facility.

Coated Reinforcing Steel Bars means reinforcing steel bars coated with epoxy.

Cold Joint means the interface surface other than at a formed joint that occurs when plastic concrete is placed against concrete that has taken its initial set.

Cold Weather means those conditions when the ambient air temperature is at or below 5 °C. It is also considered to exist when the ambient air temperature is at or is likely to fall below 5 °C within 96 hours after completion of concrete placement. Temperature refers to shade temperature.

Concrete Toe Wall means a low unreinforced concrete gravity type retaining wall no greater than 2 m in height.

Construction Joint means the surface where two successive placements of concrete meet or where new concrete is placed against old concrete across which it is desirable to achieve bond between the two concrete placements and through which steel reinforcement may be continuous.

Culvert means a structure which provides an opening through an embankment and in which roadway loads are distributed to the structure through fill or that is designated as a culvert in the Contract Documents.

Designated Limits means the dimensions of the component as shown on the Contract Drawings or the limits of the component as revised in the field in writing by the Contract Administrator.

Dowel means deformed coated reinforcing steel bar, reinforcing steel bar or stainless steel reinforcing bar placed into a hole of specified dimensions drilled into a concrete structure and bonded to the concrete by dowel adhesive.

Dowel Type means a dowel differentiated by bar size, embedment length, orientation of embedment and by bar material, such as 15M stainless steel reinforcing bar and 20M reinforcing steel bar.

High Performance Concrete (HPC) means concrete with a minimum specified 28-Day compressive strength of at least 50 MPa, that shall include silica fume and may include other supplementary cementing materials having a specified rapid chloride permeability at 28-32 Days of 1,000 coulombs or less.

Honeycombing means rough and stony concrete surface with voids where the mortar did not fill the spaces between the coarse aggregate particles.

Pull Test means an in situ test consisting of the application of a specified tensile axial load for a specified time period to installed dowels selected for testing.

Reinforcing Steel Bars means plain or deformed steel bars, or welded wire fabric, with no epoxy coating, used for the reinforcement of concrete.

R Value means the metric thermal resistance value that is a measurement of the resistance to heat transfer of insulation.

Segregation means visible separation of the mortar and coarse aggregate particles in the plastic concrete resulting in concrete that is not uniform in appearance or proportions.

Stainless Steel Reinforcing Bar means plain or deformed stainless steel bars.

Steel Reinforcement means a general term for steel bars, which includes reinforcing steel bars, splice bars, coated reinforcing steel bars, stainless steel reinforcing bars, and welded wire fabric.

Structure means any bridge, culvert, tunnel, retaining wall, wharf, dock, or guideway, or any part thereof, or other reinforced concrete component designed to carry loads, including high mast pole footings and sign support footings.

Tremie means a hopper with a vertical pipe extending from the bottom of the hopper to the lowest point of concrete deposit, used to place concrete under water.

904.04 DESIGN AND SUBMISSION REQUIREMENTS

904.04.01 Submission Requirements

904.04.01.01 Notification of Placement of Structural Concrete

At least 72 hours prior to each placing operation, the Contractor shall notify the Contract Administrator in writing of the scope and scheduling of the proposed placing operation.

904.04.01.02 Bridge Deck Placement Plan

A work plan shall be submitted to the Contract Administrator a minimum of one week prior to commencement of placing concrete in bridge decks for information purposes. The work plan shall include:

- a) The proposed methods and sequence of placing operations to be used.
- b) Complete details of all equipment to be used during the concrete placement.

904.04.01.03**Temperature Control Plans**

A temperature control plan shall be submitted to the Contract Administrator a minimum of one week prior to commencement of placing any concrete that requires temperature control, for review of compliance with the contract requirements.

The plan shall include methods for monitoring and controlling concrete temperature and the temperature difference before, during, and after placement for:

- a) Concrete subject to cold weather.
- b) HPC.
- c) Bridge decks.
- d) Large concrete components where the smallest dimension is 1.5 m.

The temperature control plan shall include, as a minimum, the following:

- a) Concrete element for which the plan applies.
- b) Temperature monitoring system, including the locations and depths, number of thermocouples, and frequencies of recordings to be used in each placement.
- c) Method of ensuring concrete temperature and temperature difference are maintained for the duration of the protection period.
- d) Any alterations to work schedule, production, delivery schedule, and time of placement for temperature control purposes.
- e) Any modification to mix design for temperature control purposes.
- f) Any other specific measures to be taken.
- g) Method of withdrawal of protection.

In addition, for concrete subject to cold weather, the temperature control plan shall also include the following:

- a) Type of insulation, R value and number of layers, including test data verifying the R value. The submission for cold weather protective measures shall be accompanied by samples of insulation, if requested by the Contract Administrator.
- b) Type and layout of heaters and type and extent of housing.

904.04.01.04**Temperature Records**

Datalogger temperature records and a record of any actions taken to maintain control of temperature and temperature difference shall be forwarded to the Contract Administrator at the end of each working day during the temperature monitoring period. At the end of the temperature monitoring period, the Contractor shall submit to the Contract Administrator a complete temperature record, including graphical plot of temperature versus time.

904.04.01.05 Curing Compound

A minimum of one week prior to the application of the curing compound, the following shall be submitted to the Contract Administrator for information purposes:

- a) Literature stating the manufacturer's recommended rate of application.
- b) Description of the equipment to be used.
- c) A statement from the manufacturer of the curing compound approving the equipment.

Test results for curing compounds shall be submitted to the Contract Administrator within 7 Days of sampling.

904.05 MATERIALS

904.05.01 Concrete

Concrete shall be according to OPSS 1350.

904.05.02 Portland Cement

Portland cement shall be according to OPSS 1301.

904.05.03 Sand

Sand shall be according to OPSS 1002.

904.05.04 Bonding Agents

Bonding agent shall consist of Portland cement, Type GU, and sand in the ratio of 1:1 by volume and water sufficient water to produce a consistency such that it can be applied with a stiff brush to the existing concrete in a thin even coating that shall not run or puddle.

904.05.05 Mortar

Mortar shall be a 2:1 mixture by volume of sand and Portland cement, Type GU, and shall contain 12% entrained air with water sufficient to make a stiff mix.

904.05.06 Proprietary Patching Materials

Proprietary patching materials shall be from the ministry's list of concrete patching materials.

904.05.07 Burlap

The burlap shall be according to AASHTO M182, Class 4, and shall be free from substances that are deleterious to concrete. The burlap shall have no tears or holes.

904.05.08 Water

Water used for curing and fog misting of concrete, including pre-soaking of burlap, and for making bonding agents and mortar and mixing proprietary patching materials, shall be according to OPSS 1302.

904.05.09 Moisture Vapour Barrier

The material shall be a white opaque polyethylene film according to ASTM C 171, at least 100 µm thick.

904.05.10 Curing Compound

Curing compound shall be according to OPSS 1315.

904.05.11 Approach Slab Seat Elastomer

The elastomer delivered to the site shall exceed the required length to allow for a 600 mm test sample to be taken from each structure.

The elastomer shall be according to the plain bearing requirements of OPSS 1202, except that the hardness of the elastomer shall be a minimum of 50 Shore A, and the elastomer shall have a minimum tensile strength of 15 MPa.

904.05.12 Insulation Material

Insulation material shall be mineral wool, glass fibre, plastic foam or other suitable material, having an R value not less than 0.02 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.

904.05.13 Dowels

Dowels shall be as specified in the Contract Documents. Dowels shall be capable of sustaining the pull test loads specified in Table 1 without displacement for a time period of not less than 1 minute.

904.05.14 Dowel Adhesive

Dowel adhesive shall be an approved epoxy or acrylic resin.

904.06 EQUIPMENT

904.06.01 General

Equipment made of aluminium material shall not come in contact with the plastic concrete.

904.06.02 Concrete Pump

The concrete pump shall be a reciprocating pump equipped to fit a pipeline at least 100 mm in diameter.

904.06.03 Consolidating Equipment

Internal vibrators shall be of the high frequency type with 8,000 minimum to 12,000 maximum vibrations per minute when immersed in concrete.

Internal vibrators used to consolidate concrete components containing epoxy coated steel reinforcement shall have a resilient covering that shall not damage the epoxy-coated reinforcement during use.

External vibrators shall have a minimum frequency of 3,600 vibrations per minute.

904.06.04 Mixer for Bonding Agents

The mixer for the bonding agent shall be a stationary mixer, power driven, and capable of uniformly mixing the materials.

904.06.05 Finishing Machine

The finishing machine shall:

- a) Be self-propelled and capable of forward and reverse movement under positive control.
- b) Be fitted with wheels that travel on adjustable screed rails.
- c) Be fitted with a reversing rotating cylinder screed capable of finishing the concrete without subsequent hand finishing.
- d) Be fitted with a reversing power screw auger.
- e) Be capable of externally vibrating the surface of the concrete by means of a plate or roller.
- f) Be fitted with a means to raise all screeds to clear the screeded surface and to accurately reposition them without adjusting the legs.
- g) Have adjustable legs fitted with locking devices.

904.06.06 Screed Rails

The rails shall be made of metal and be straight to within 3 mm in a 3 m length. Screed rail chairs shall be adjustable in height, made of metal, and spaced at a maximum of 1.2 m and be placed under all rail joints. Maximum deflection of the screed rails under load shall be 2 mm in a 1.2 m length.

904.06.07 Work Bridges

Work bridges shall be provided to facilitate surface finishing of unscreeded areas, corrections to surface finish, concrete inspection, and placing of curing materials.

Work bridges shall ride on the screed rails and the top surface of a work bridge shall not be higher than 1.0 m above the finished surface.

904.06.08 Hand Finishing Tools

Floats shall be made of magnesium or wood. Magnesium bull floats shall be commercially made.

904.06.09 Straight Edges

Two straight edges commercially made of metal, one 3 m and one 500 mm long, shall be used.

904.06.10 Tremie

The tremie shall be equipped with a foot valve at the bottom of the pipe. The pipe shall have a 300 mm $\pm$ 50 mm inside diameter and shall be long enough to extend to the lowest point of concrete deposit.

904.06.11 Spray Equipment for Curing Compound

The curing compound shall be applied to the concrete surface by means of motorized spraying equipment approved by the manufacturer of the curing compound. The equipment shall include mechanical agitator.

904.06.12 Compressor - Air Blasting

The compressor for air blasting shall have a minimum capacity of 3.5 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 before any concrete is placed. This requirement does not apply to the bottom slab of post-tensioned box voided decks.

904.07.03 Deck Joint Assemblies and Joint Material

Deck joint assemblies, joint fillers, joint seals, joint sealing compounds, and external waterstops shall be according to OPSS 920.

904.07.04 Preparation for Concrete Placement

904.07.04.01 General

All concrete surfaces against which new concrete is to be placed, including formed and sawcut surfaces, shall be clean, solid, and free from loose or unsound fragments, coatings, and any other foreign substances or debris and shall be sufficiently rough to ensure that a full bond is developed with the new concrete. The concrete surface shall be uniformly roughened to a surface profile of 5 mm ± 2 mm by means of methods such as scabbling, chipping, or bushhammering to expose the aggregates across the entire surface. Roughening is not required for the vertical faces of slope paving or for new concrete substrate with a roughened finish, imparted at the time of placement, meeting the profile requirement.

904.07.04.02 Abrasive Blast Cleaning

The following surfaces shall be abrasive blast cleaned according to OPSS 929:

- a) All existing steel reinforcement that shall be incorporated into the rehabilitation of a concrete structure component.
- b) All surfaces of existing structural steel against which new concrete shall be placed for the rehabilitation of a concrete structure component.
- c) All new or existing concrete surfaces against which new concrete shall be placed.

904.07.04.03 Pre-wetting

All concrete surfaces to receive concrete shall be maintained in a wet condition for a period of 1 hour prior to placing any new concrete.

Immediately prior to wetting the concrete surface, all dust and loose material shall be removed from the prepared surface by using compressed air.

Prior to placing concrete, excess water shall be removed from the surface using compressed air.

904.07.04.04 Bonding Agent

A bonding agent shall be used for:

- a) Vertical surfaces of concrete against which new concrete is to be placed.
- b) Blockouts in concrete for installation and modification of deck joint assemblies.
- c) Stressing tendon anchorage recesses.

A thin uniform coating of bonding agent shall be brushed onto the prepared surface immediately before placing fresh concrete. Bonding agents shall be mixed by means of a mixer. Any bonding agent not used within 30 minutes of mixing shall be discarded. Bonding agent that has dried shall be removed and replaced prior to placing concrete against it.

904.07.04.05 Element-Specific Preparation

For concrete in footings, when it is specified in the Contract that the concrete is to be placed against undisturbed soil or set in rock, any over-excavation shall be filled with concrete of the same strength as the footing concrete.

For parapet and barrier walls and curbs on structures, all anchorages shall be fastened in place accurately and securely before proceeding with concrete placement. The railing anchorage inserts shall be fastened in place according to OPSS 908.

For concrete in approach slabs, the approach slab seat elastomer, polystyrene, and joint filler shall be installed and the subgrade thoroughly wetted down prior to placing the concrete in the approach slab, including the adjacent sidewalk slab.

For concrete in slope paving, the slope face shall be shaped; excavation completed; granular A placed and compacted; and the crushed rock, moisture vapour barrier, wood strips, and joint filler shall be placed as required prior to placing the concrete. Sealant shall be installed as specified in the Contract Documents.

The granular A shall be compacted according to OPSS 501.

904.07.05 Dowels into Concrete

904.07.05.01 General

The Contractor shall carry out pull testing of dowels in the trial installations and during production. Pull test loads shall be according to Table 1. The Contractor shall notify the Contract Administrator in writing when the trial installation or a lot, as defined in the Lot Size clause, is ready for testing. The Contractor shall allow 3 Business Days for the Contract Administrator to witness the testing.

The Contractor shall provide documentation of equipment calibration to the Contract Administrator a minimum of 14 Days prior to any pull testing of the dowels.

904.07.05.02 Trial Installation

Prior to installing each dowel type specified in the Contract Documents, the Contractor shall carry out a trial installation of that dowel type at locations selected by the Contract Administrator.

Each trial installation shall consist of a set of three dowels. If the Contractor changes the installation procedure for a dowel type from that used in the associated trial installation, the Contractor shall repeat the trial installation prior to incorporating dowels installed using the changed installation procedure into the work.

Each of the three dowels in the set shall be capable of achieving the specified test load and times, without any movement of the dowels, for the trial installation to be considered acceptable.

If the trial installation is not acceptable, installation of that dowel type in the work shall not be permitted until the following have been carried out by the Contractor to the satisfaction of the Contract Administrator:

- a) A written explanation for the failure has been submitted.
- b) Corrective action to be taken has been identified.
- c) The trial installation has been repeated with acceptable results.

If a dowel is not capable of achieving the test load and time due to failure of the surrounding concrete, the Contractor shall not be permitted to install any additional dowels of that type in the work until further advised by the Contract Administrator.

904.07.05.03 Installation

The Contractor shall drill holes to the required dimensions, clean holes, place dowel adhesive, and properly position the dowels as specified in the Contract Documents. Core drilling of the dowel holes shall not be permitted.

Steel reinforcement and other existing embedments shall not be cut or damaged by the drilling process. Prior to drilling holes, the Contractor shall locate existing steel reinforcement using a covermeter, Utility ducts, post tensioning hardware, and any unsound concrete in the vicinity of the dowel locations. If any of the above is encountered during drilling operations, the Contract Administrator shall be notified immediately.

The Contractor's operations shall not cause spalling, cracking, or other damage to the surrounding concrete. Concrete spalled or otherwise damaged by the Contractor's operations shall be repaired in a manner acceptable to the Contract Administrator.

The Contractor shall clean the holes using compressed air to remove all deleterious material, including dust and debris, and shall dry them prior to placing the dowel adhesive. Holes that are started but not completed shall be cleaned and filled with a proprietary patching material.

The handling and placement of the dowel adhesive shall conform to the manufacturer's written instructions. All excess dowel adhesive shall be struck-off flush with the concrete surface and removed from the surrounding concrete surface area.

Dowels shall be clean and free of deleterious material.

The Contractor shall maintain dowels in the proper position during the setting of the dowel adhesive and shall prevent the loss of dowel adhesive from the holes.

904.07.05.04 Pull Test

904.07.05.04.01 General

The Contractor shall not install formwork or attach anything to the dowels such as steel reinforcement and Utility ducts until the pull tests have been completed and the dowels are accepted into the work.

904.07.05.04.02 Lot Size

A lot shall consist of dowels of the same dowel type installed on a given day, in a single stage. Where a given day's production is less than 50 dowels, the day's work may be combined with the next day's production to form a single lot.

904.07.05.04.03 Pull Test Procedure

The Contractor shall conduct pull testing for the trial installation and each lot within 3 Business Days of installation. The Contract Administrator shall be present during the testing procedure. The Contract Administrator shall randomly select 5% of the dowels in each lot or 10 dowels, whichever is greater, for testing. The applicable pull test load shown in Table 1 must be sustained by the dowel, without displacement, for a time period of no less than one minute.

904.07.05.05 Replacement of Failed Dowels

All dowels failing the pull test requirement, including trial installation dowels, shall be replaced by the Contractor by installing a new dowel in an adjacent location approved by the Contract Administrator.

Dowels failing the pull test requirement, including trial installation dowels, shall be removed and the hole filled with proprietary patching material.

904.07.06 Placing of Concrete

904.07.06.01 General

The method of transporting, placing, and consolidating the concrete shall be such as to prevent segregation.

Concrete shall be deposited within 1.5 m of its final position. When concrete is to be dropped more than 1.5 m, fully enclosed vertical drop chutes extending to the point of deposit shall be used. Drop chutes are not required for placing concrete in steel tube piles of 0.6 m diameter or less. Concrete shall be placed at a steady rate, such that a monolithic concrete is obtained without the formation of cold joints.

When there is an interruption in placing concrete greater than 20 minutes, the surface of the concrete shall be covered with wet burlap. The Contractor shall notify the Contract Administrator immediately of any interruption resulting in a cold joint and shall submit a proposal for remedial action for approval.

904.07.06.02 Concrete Placing Restrictions

No concrete shall be placed until all curing material and, in cold weather, all cold weather protection material, have been delivered to the site.

Barrier and parapet walls on structures shall not be slipformed.

When concrete is to be placed on a surface that has a slope greater than 3%, the placing operation shall begin at the lower end of the slope and progress upwards.

All surfaces against which concrete are to be placed shall be free of standing water, except for tremie concrete. Fresh concrete shall be protected from contact with rain or snow.

The temperature of formwork, steel reinforcement or the material on which the concrete is to be placed shall not exceed 30 °C.

Debris shall be removed from the area where concrete is to be placed.

Ice and snow shall be removed from the area where concrete is to be placed. Deicing chemicals shall not be used. Concrete shall not be placed on or against frozen ground. Excavations prepared for concreting and any existing concrete, steel reinforcement, structural steel, forms, or other surfaces against which concrete shall be placed shall be at a minimum temperature of 5 °C for a period of 12 hours prior to commencement of placing concrete.

904.07.06.03 Concrete in Structure and in Deck

Concrete diaphragms shall be placed monolithically with the deck.

All bridge deck placements 3 m or wider shall be finished using a finishing machine and a work bridge. Where placements are longer than 40 m or wider than 10 m, a second work bridge shall be used. For deck placements narrower than 3 metres, the Contractor shall submit a proposal detailing a method of finishing to the Contract Administrator for approval. Small, localized areas may be hand finished subject to approval by the Contract Administrator.

Where the superstructure is continuous over a support, the screed rails shall be placed for the entire length of the structure before any concrete is placed.

A dry run shall be carried out to ensure that the specified camber, crown, slab thickness, and concrete cover are achieved. In those areas of the deck where a finishing machine will be used to finish the concrete, the dry run shall be carried out by means of the finishing machine fitted with an attachment suitable for checking the required cover, securely fastened to the finishing machine strike-off, with the strike-off set in its lowest position. This operation shall be repeated to cover the entire area to be concreted.

For HPC and silica fume overlay, at the time of the dry run the Contractor shall demonstrate that the performance of the fog misting equipment meets the specified requirements.

Screed rails and the supports for the screed rails shall not be removed until the concrete has hardened sufficiently to withstand the weight of workers and equipment used to remove them without marring the surface of the concrete. Any part of the screed rail supports that remain in the deck shall have 100 mm of concrete cover. Chairs used to support screed rails shall not be welded to structural steel but may be welded to shear connectors.

The holes in the deck resulting from removal of the screed rail supports shall be thoroughly cleaned of all deleterious material and abrasive blast cleaned immediately prior to filling with proprietary patching material. The work of cleaning and filling the holes shall be completed within 96 hours after the end of the deck curing period.

904.07.06.04 Tremie Concrete

Concrete shall be placed using a tremie or concrete pump. No air or water pockets shall be introduced into the tremie concrete by the placing equipment.

Pipe of a tremie or hose of a concrete pump shall be positioned vertical and shall be long enough to reach the lowest point of concrete deposit. A continuous flow of concrete at a minimum rate of 15 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 2 °C or greater. The velocity of water flow inside the forms shall not be more than 3 m/min.

When placing the tremie pipe or concrete pump hose and at the start of the concreting operation, the pipe or hose shall be sealed at the bottom to prevent ingress of water. Once concrete is flowing through the pipe or hose, the discharge end shall be kept continuously immersed in the freshly placed concrete. If the seal is lost, thereby allowing the pipe or hose to fill with water, the pipe or hose shall be withdrawn, the seal re-established, and the starting operation repeated. Separate cranes shall be used to deliver the tremie concrete and to move and position the tremie or concrete pump.

Tremie concrete shall not be placed above the existing water level.

When a placement operation is interrupted below water level, the surface laitance shall be removed to expose the coarse aggregate within 36 hours after the interruption and before continuation of the operation.

When a placement operation is completed and work is to continue in the dry, the Contractor shall prepare the construction joint by removing surface laitance to expose the coarse aggregate.

Unwatering shall not be permitted until at least 24 hours after the concrete placement is completed.

904.07.07 On-Site Transportation

Runways for buggies shall be of sufficient strength to prevent shaking and jarring of the buggies and steel reinforcement.

Concrete placing and transporting devices shall not be supported by the steel reinforcement.

Chutes shall have sufficient slope to deliver concrete of the approved consistency and shall have a maximum length of 15 m.

904.07.08 Consolidation

Internal or external vibrators or both shall be used to thoroughly consolidate concrete at the point of deposit within 15 minutes of placing.

Each layer of concrete shall be vibrated. Vibrators shall extend into the previous layer to produce a homogenous mixture at the layer interface.

Vibration shall not be used to make the concrete flow or to spread the concrete more than 1.5 m from the point of deposit.

904.07.09 Concrete Finishing

Finishing of the concrete surface shall be done while it is sufficiently plastic to achieve the desired grades, elevations, and texture. The Contractor shall ensure that excessive fines and water are not drawn to the surface.

No material shall be applied to the concrete surface or the finishing tools to aid in the finishing.

The surface shall be smooth, free from open texturing, undulations, projections, and ridges and shall be struck off true to grade and cross-section and, except as specified for bridge deck placements, shall be hand finished with a float.

Bearing seats and expansion joint dams shall receive a wood float finish. The top surface of sidewalks and curbs shall be given a broomed finish. Bridge decks shall be finished according to the Concrete in Structure and in Deck clause. In addition, for bridge decks where the concrete forms the wearing surface, the surface shall be textured. Texturing shall be done with a wire broom or comb having a single row of tines after a tight, uniform surface has been achieved. The required texture shall be transverse grooves that may vary from 1.5 mm width at 15 mm centres to 4.5 mm width at 20 mm centres with a groove depth varying from 3.0 mm to 4.5 mm. The texture shall extend uniformly to within 150 to 300 mm of the curb. Concrete surfaces against which new concrete shall be placed shall be left with a rough surface finish.

904.07.10 Curing

904.07.10.01 General

The curing period shall be a minimum of 7 Days for concrete subject to cold weather, concrete cured with curing compound, and HPC. For all other concrete, the curing period shall be a minimum of 4 Days.

When the ambient air temperature is 0 °C or higher at the time of placing, components of structures shall be cured with burlap and water except as specified in the Curing Formed Surfaces clause. When the ambient air temperature is below 0 °C at the time of placing, components shall be cured with moisture vapour barrier, except for HPC, which shall be moist cured with burlap and water regardless of ambient air temperature. During cold weather, burlap shall be prevented from freezing.

Curing compound shall only be permitted for non-structural elements such as slope paving.

904.07.10.02 Fog Misting of High Performance Concrete

The Contractor shall provide fog misting by hand held fogging wands and may also employ a fogging system mounted on the finishing machine.

Fog mist shall be applied from the time HPC is deposited in the deck, approach slab, median, curb, or sidewalk until it is covered with burlap.

Fog mist shall be applied using misting nozzle in such a way as to maintain a fog mist above the concrete surface to maintain high relative humidity above the concrete and prevent drying of the concrete. No accumulation of water shall be permitted on the concrete surface. Water from fog misting nozzles shall not be worked into the concrete surface or used as a finishing aid.

904.07.10.03 Curing with Burlap and Water

Burlap shall be pre-soaked by immersing it in water for a period of at least 24 hours immediately prior to placing. Two layers of burlap shall be applied to the surface of the concrete. The burlap shall be applied immediately after finishing the concrete surface. For continuing operations, such as barrier wall or sidewalk, the burlap shall be applied within 2 to 4 m of the finishing operation, and for bridge decks, within 2 to 4 m of the pan or screed of the finishing machine. Burlap strips shall overlap 150 mm and shall be held in place without marring the surface of the concrete.

The burlap shall be maintained in a continuously wet condition throughout the curing period by means of a soaker hose. The burlap shall be covered with a layer of moisture vapour barrier, within 12 hours of placing of the concrete, in a manner that shall prevent deformation of the surface of the concrete.

Air flow in the space between the moisture vapour barrier and the burlap shall be prevented.

Water shall not be allowed to drip, flow, or puddle on the concrete surface when placing the burlap or at any time before the concrete has achieved final set.

Where waterproofing is to be applied to a structure deck following curing with burlap and water, the deck shall be air dried for at least 72 hours prior to the application of waterproofing.

904.07.10.04 Curing with Moisture Vapour Barrier

A moisture vapour barrier shall be placed immediately after finishing the concrete surface, within 2 to 4 m of the finishing operation. Air flow in the space between the moisture vapour barrier and the concrete surface shall be prevented. The moisture vapour barrier strips shall overlap 150 mm and shall be held in place at the edges and laps to prevent displacement, without marring the surface of the concrete.

904.07.10.05 Curing with Curing Compound

Immediately prior to application, the curing compound shall be agitated by mechanical means to provide a homogeneous mixture. It shall be applied immediately after finishing of the concrete surface, within 2 to 4 m of the finishing operation, completely covering the surface of the concrete. A second application of curing compound shall be applied within 30 to 60 minutes after the first application. Each application shall be such that the membrane formed is uniform in thickness and colour and free of breaks and pinholes.

The rate of each application shall not be less than the rate specified by the manufacturer of the compound.

904.07.10.05.01 Curing Compound Sampling and Testing

The Contractor shall be responsible for sampling and testing curing compounds. Curing compounds shall be sampled at the site, from the spray nozzle, in the presence of the Contract Administrator. Samples shall be taken at a frequency of one sample per contract or one sample per 1,000 lineal meters, whichever provides the greater number of samples. Testing shall be carried out by a laboratory on the ministry's list of laboratories qualified for this testing. Testing for relative density, non-volatile content, and settlement shall be carried out according to LS-413, LS-414, and LS-416.

904.07.10.06 Curing Formed Surfaces

Forms for structure barrier wall, parapet wall, and curb on deck shall be removed no later than 24 hours after concrete placement, and the concrete shall be cured according to the Curing with Burlap and Water clause for the remainder of the minimum curing period.

Other formed surfaces shall require no additional curing where the formwork is left in place for the minimum specified curing period. Where the formwork is removed before the curing period is completed, formed surfaces shall be cured with burlap and water according to the Curing with Burlap and Water clause for the remainder of the minimum curing period.

For all concrete other than HPC, when ambient air temperatures are 5 °C or less, forms for concrete barrier wall, parapet wall, and curb on deck may be left in place for the duration of the curing period. When forms are left in place, exposed concrete surfaces of these components shall be cured with vapour barrier.

904.07.11 Control of Temperature and Temperature Difference

904.07.11.01 General

The Contractor shall ensure that during the curing period the concrete temperature does not fall below 10 °C or exceed 70 °C. The Contractor shall also ensure that the temperature difference between the centre of the concrete component at a location where the concrete is expected to reach the highest temperature and the surface does not exceed 20 °C, for:

- a) Any concrete subject to cold weather.
- b) HPC.
- c) Large concrete components where the smallest dimension is 1.5 metres.
- d) All bridge decks.

904.07.11.02 Monitoring

The Contractor shall monitor the concrete and ambient air temperature for:

- a) Any concrete subject to cold weather.
- b) HPC.
- c) Large concrete components where the smallest dimension is 1.5 metres.
- d) All bridge decks.

The Contractor shall supply and install thermocouple wires and associated instrumentation with a combined accuracy of ± 1 °C capable of recording and displaying temperature. The instrumentation shall include data loggers capable of recording at hourly intervals or less and shall allow direct reading of temperature.

The thermocouples for concrete temperature measurement shall be installed according to Table 2 prior to placing concrete. Thermocouples for monitoring ambient air temperature shall be installed in the shade close to the surface of the concrete at a frequency of 1 thermocouple per stage.

Recording of concrete temperatures shall begin at the start of placement. The temperature shall be recorded automatically at intervals no greater than 1 hour until the end of the monitoring period. The monitoring period shall be 7 Days or longer when necessary in order to meet the requirements of the Withdrawal of Protection clause.

The Contractor shall also monitor and verify concrete and ambient air temperature every 6 hours, or more frequently, for the first 3 Days and every 12 hours for the remainder of the monitoring period. The Contractor shall take necessary action to maintain the temperature within the specified limits.

The Contract Administrator shall be provided access to verify temperature readings. The digital temperature indicators shall be left in place until the end of the monitoring period. If the datalogger does not have a digital display that allows the Contract Administrator to verify temperature, the Contractor shall provide the Contract Administrator with the necessary instruments to allow the Contract Administrator to verify thermocouple function and readings.

904.07.11.03 Concrete Subject to Cold Weather

The Contractor shall design the protection system for the worst conditions that can be reasonably anticipated from local weather records, forecasts, site conditions, and past experience for the time period during which the protection is required. The Contractor shall monitor the conditions and modify the protection system as required.

For cold weather conditions, minimum protection of concrete shall be according to Table 3 and shall be maintained for the duration of curing period. This period may need to be extended in order to meet the requirement of the Withdrawal of Protection clause.

904.07.11.03.01 Housing and Heating

The design of the protective housing shall take into account the effects of construction activities such as placing concrete, stressing, and grouting. Heating equipment of sufficient capacity to establish and maintain the specified curing conditions shall be used throughout the curing period and for such time thereafter as is necessary for the completion of the work. Heating equipment used within the housing shall be vented outside the housing. Heating equipment having an open flame shall not be permitted.

The ambient air temperature adjacent to the concrete or formwork within the housing shall not be permitted to vary by more than 8 °C.

904.07.11.04 Withdrawal of Protection

For concrete subject to cold weather and for large concrete components where the smallest dimension is 1.5 metres, the protection shall be gradually removed or reduced in such a manner that the maximum allowable drop of concrete temperature, as specified in Table 4, for each 24-hour period is not exceeded.

The protection shall not be totally removed nor shall the concrete be fully exposed to the air until the average concrete temperature is within 10 °C of the ambient air temperature.

904.07.12 Removal of Formwork and Falsework

The removal of formwork and falsework shall be according to OPSS 919 and the Contract Documents.

904.07.13 Construction Joints

The Contractor shall form construction joints at the locations shown on the Contract Documents.

In addition, construction joints can be formed where control joints are specified in barrier walls and parapet walls. No other construction joints shall be permitted unless approved in advance by the Contract Administrator.

A straight 20 mm V-groove shall be formed at the exposed face of the concrete at all construction joints. V-grooves shall not be used on bridge deck surfaces, except for the bottom slab of post tensioned box voided slabs.

A bulkhead shall be used to form vertical or inclined construction joints.

904.07.14 Surface Finish

904.07.14.01 General

Concrete surfaces shall not be treated with cement slurry or paste.

Within 3 Days following the removal of forms or curing materials, all holes left in the concrete surface with dimension greater than 15 mm and less than 50 mm shall be filled with mortar or a proprietary patching material. The holes shall be moist at the time of filling. Mortar shall be tamped into place. Proprietary patching materials shall be placed according to manufacturer's instructions.

Surfaces with cavities greater than 50 mm or with honeycombing are considered deficient and shall be repaired. The Contractor shall submit a repair proposal to the Contract Administrator for approval.

904.07.14.02 Exposed Surfaces

The appearance of the concrete shall be uniform in colour, pattern, and texture when viewed from a distance of 15 m. Where a patch is exposed to view, white Portland cement shall be blended with the normal cement to achieve a uniformity of colour. To ensure this uniformity, trial mixes shall be made beforehand and sample panels compared with the main body of the concrete.

The Contractor shall remove all projections, such as fins and bulges, and all blemishes, such as stains and rust marks.

Proprietary patching materials shall be selected to achieve uniformity of colour and appearance.

904.07.14.03 Surface Tolerance

Formed and unformed surfaces shall be such that, when tested with a 3 m long straight edge placed anywhere in any direction on the surface, there shall be no gap greater than 6 mm between the bottom of the straight edge and the surface of the concrete. When the straight edge is placed across a construction joint the gap between the straight edge and the surface of the concrete shall not be greater than 3 mm.

All unformed construction joint surfaces against which sidewalks, curbs, medians, and barrier walls are to be placed shall be such that, when tested with a 500 mm straight edge placed anywhere in any direction on the surface, there is no gap greater than 20 mm between the bottom of the straight edge and the surface of the concrete.

904.07.14.04 Contamination of Surface

Contamination by oil or other deleterious substances shall be prevented. Contaminated concrete in bridge decks or against which new concrete is to be placed shall be removed according to OPSS 928, procedure for Concrete Removal-Partial Depth-Type A, B, and C.

904.07.15 Alignment of Components

The position of the inner and outer top edges of structural components shall be set true to the elevations, alignment, and camber specified in the Contract Documents without visible deviation from one end of the structure to the other. All concrete items or structural components shall be constructed to the specified geometry.

Variations from plumb or a specified slope shall not exceed 1H:400V. Departure from specified alignment shall not exceed ± 25 mm.

904.07.16 Testing for Early Strength

The Contractor may, at his option, prepare sets of cylinders for early strength determination in addition to the cylinders required for determination of strength at 28 Days.

The Contractor shall be responsible for all aspects of the preparation, storing, and transportation of cylinders for early strength determination. Curing of cylinders for early strength determination shall consist of storing the cylinders in or on the structure as near as possible to the component that they

represent. The cylinders shall receive the same protection from the elements on all surfaces as is given to the portions of the structure that they represent. The Contractor shall identify the time of testing for early-break cylinders and provide the Contract Administrator with 1 Business Day advance notice to arrange testing. The Contractor shall deliver cylinders for early strength determination immediately prior to the time of testing. The Owner shall test a reasonable number of cylinders for early strength determination at the laboratory designated in the Contract.

Early strength determination of concrete in post-tensioned structures shall be carried out on a minimum of four sets of cylinders representative of the concrete placed in the structure. At least one set of cylinders from the start, middle, and end of the deck section being placed, shall be cast. All cylinder test results must reach the minimum stressing strength specified in the Contract Documents before stressing can commence.

904.07.17 Cracks in Formed and Unformed Surfaces

The Contractor shall inspect all concrete to identify and document any cracks including, their location, width, and density. The results of the inspection shall be reported to the Contract Administrator. The Contractor shall continue to inspect and monitor cracks up to the date of Completion of the Work.

Based on criteria in Table 5, the Contractor shall identify areas requiring repair or replacement, and shall identify the limits of such repair or replacement. This information shall be provided to the Contract Administrator along with a proposal for remedial action to be taken. No repairs shall proceed until the proposal has been accepted by the Contract Administrator in writing.

Repairs shall be according to OPSS 932. Where removal is required, the removals and preparation of concrete shall be according to OPSS 928 and OPSS 930.

For bridge decks to be waterproofed, the inspection of the surface to be waterproofed shall be carried out after completion of curing and before application of tack coat for waterproofing. For all other concrete, the inspection shall be carried out in a timely manner but no later than one month following completion of curing. The Contractor shall not proceed with waterproofing of a bridge deck until repairs have been completed and permission to waterproof has been given by the Contract Administrator.

904.07.18 Concrete Cover

The Contractor shall clear all debris and obstructions and provide unhindered access to allow the Contract Administrator to carry out the concrete covermeter survey as specified in the Concrete Cover subsection of the Quality Assurance section. The Contractor shall notify the Contract Administrator in writing when the test area is ready for the concrete covermeter survey.

The Contractor shall allow the Contract Administrator a time period of 3 Business Days to complete the survey, including review of the survey by the Owner. This time period shall commence upon receipt of the Contractor's written notification to carry out the survey. The time period required to complete the concrete survey shall be extended if inclement weather or the ambient air temperatures below 5 °C fall within that time period.

Where the cover does not meet the Contract requirements, the Contractor shall submit a proposal for remedial action for approval by the Contract Administrator.

The Contractor shall not proceed with waterproofing of a bridge deck until the survey has been completed and permission to waterproof has been given by the Contract Administrator.

For all other components, the inspection of the surface shall be carried out in a timely manner, no more than one month after removal of curing.

904.07.19 Management of Excess Material

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

904.08 QUALITY ASSURANCE

904.08.01 Acceptance

Acceptance shall be according to OPSS 1350 and this specification, including satisfactory completion of all remedial action associated with surface tolerance, surface finish, concrete cover, alignment, cracks, and dowel bars and any other deficiencies.

904.08.02 Concrete Cover

The concrete cover shall meet the Contract requirements. Concrete cover determination shall be carried out by the Contract Administrator on the front faces of barrier or parapet walls, and the top surface of decks, including medians and sidewalks. The Contract Administrator shall provide the survey report to the Contractor.

904.08.03 Approach Slab Seat Elastomer

The Contract Administrator shall select a random sample of the approach slab seat elastomer, 600 mm in length, from each structure for testing.

The Contractor shall allow 60 Days from the time of submission of the sample for the Owner's testing program.

The approach slab seat elastomer samples shall be delivered by the Contractor to the Contract Administrator.

Approach slab seat elastomer that does not meet the Contract requirements shall be considered unacceptable.

904.08.04 Dowels into Concrete

904.08.04.01 Acceptance of Dowels into Concrete

If more than one dowel fails, the lot of dowels shall be considered unacceptable and the Contractor shall complete the following:

- a) Conduct pull tests on all remaining untested dowels of the lot.
- b) On the subsequent lot, conduct pull tests on 10% of dowels or 20 dowels, whichever is greater. If more than one dowel fails, all remaining untested dowels of that lot shall be tested.
- c) The subsequent lot shall be tested at the higher frequency until no more than one tested dowel fails.

The Contractor shall pull test all replacement dowels in the presence of the Contract Administrator. Each replacement dowel shall be accepted individually.

Dowels shall not be subjected to more than one pull test.

904.09 MEASUREMENT FOR PAYMENT

904.09.01 General

No deductions from the volume of concrete shall be made for any of the following:

- a) Drainage openings, load reducing devices, embedded timbers, and Utility and prestressing steel ducts, each of which has a cross-sectional area of less than 0.1 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.

904.09.02.02 Dowels into Concrete

For measurement purposes, a count shall be made of the number of dowels installed.

904.09.03 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement

904.10 BASIS OF PAYMENT

904.10.01 Concrete in Culverts - Item Mass Concrete - Item Tremie Concrete - Item Concrete in Footings - Item Concrete in Barrier Wall Footings - Item Concrete in Structure - Item Concrete in Substructure - Item Concrete in Substructure and Retaining Walls - Item Concrete in Deck - Item Concrete in Barrier Walls - Item Concrete in Parapet Walls - Item Concrete in Approach Slab - Item Concrete in Slope Paving - Item Concrete in Toe Wall - Item Prestressed Concrete Bridge Deck - Item High Performance Concrete in Substructure - Item High Performance Concrete in Structure - Item High Performance Concrete in Approach Slab - Item High Performance Concrete in Deck - Item

High Performance Concrete in Barrier Walls - Item
High Performance Concrete in Parapet Walls - Item
High Performance Concrete in Substructure and Retaining Walls - Item

Payment at the Contract price for the concrete tender items shall be full compensation for all labour, Equipment, and Material to do the work, subject to payment adjustments specified in the Contract Documents.

Surface cavities greater than 50 mm and honeycombing shall be repaired at no cost to the Owner.

904.10.02 Dowels into Concrete - Item

Payment at the Contract price for the tender items shall be full compensation for all labour, Equipment, and Material to do the work, except that payment for the reinforcing steel bars or coated reinforcing steel bars or stainless steel reinforcing bars used as the dowels shall be according to OPSS 905.

No payment shall be made for dowels that fail the pull test, except where the failure is due to concrete breakout.

Repair to the concrete required due to Contractor's operations shall be made at no cost to the Owner.

For any dowels that fail the pull test as a result of concrete breakout failure and not by bond failure, payment for repairs to concrete resulting from concrete breakout failure during the pull test and the cost of the replacement dowel shall be made as Extra Work.

The cost of additional testing according to the Acceptance of Dowels into Concrete clause shall be at the Contractor's expense and shall be a lump sum of \$1,000 with additional cost of \$50 per dowel.

904.10.03 Formwork and Falsework

Payment for formwork and falsework shall be included in the work in which it is used.

Where formwork is required for the work under a concrete tender item, it shall be deemed for progress payment purposes that the formwork, together with its supporting falsework, when installed, constitutes 35% of the work to be carried out under the tender item.

Partial payment for construction of the formwork and falsework shall be made on a prorated basis.

904.10.04 Working Slabs

When a concrete working slab is required by the Contract Administrator, payment shall be made as Extra Work at the unit price of the concrete in the footing to be placed on it.

904.10.05 Deck Joint Assemblies, Bearings, and Deck Drains

When the Contract does not contain a separate tender items for deck joint assemblies, bearings, and deck drains, the Contract price for the concrete tender items in which the deck joint assemblies, bearings, and deck drains are incorporated shall include full compensation for all labour, Equipment, and Material required to place the deck joint assemblies, bearings, and deck drains.

904.10.06 Reinforcing Steel Bars, Coated Reinforcing Steel Bars, or Stainless Steel Reinforcing Bars

When the Contract does not contain a separate tender item for reinforcing steel bar, coated reinforcing steel bar or stainless steel reinforcing bar, the Contract price for the concrete tender item in which the steel reinforcement is incorporated shall include full compensation for all labour, Equipment, and Material required to place the reinforcing steel bars, coated reinforcing steel bars or stainless steel reinforcing bars.

TABLE 1
Pull Test Loads

Dowel Size	Test Loads kN	
	Embedment depth less than 200 mm	Embedment depth 200 mm or greater
10M	20	35
15M	40	70
20M	60	110
25M	100	180
30M	140	250
35M	190	340

TABLE 2
Minimum Number of Thermocouple Sets for Concrete Temperature Measurement

	Concrete Elements Requiring Temperature Monitoring	Number of Thermocouple Sets in Each Element	Number of Thermocouples in Each Set	Thermocouple Set Locations
Cold weather protection	Each concrete element	Minimum of 3 per element or stages thereof	2	In locations where the concrete is expected to reach the highest temperature and at the surface of concrete.
Bridge Decks	All	1) Minimum of 3 per stage, or per deck if deck is not placed in stages. 2) When diaphragm is cast together with a deck a minimum of 4 per stage.	3	The beginning, middle, and final portion of the deck placement and in the diaphragm. In locations where the concrete is expected to reach the highest temperature and at the surfaces of concrete. (Note 1)
HPC	Substructure elements: abutments, pier columns, and pier caps	Minimum of 3 per element or stages thereof	2	In locations where the concrete is expected to reach the highest temperature and at the surface of concrete.
Large concrete components where the smallest dimension is 1.5 metres	Elements with smallest dimension of 1.5 m or more	Minimum of 3 per element or stages thereof	2	In locations where the concrete is expected to reach the highest temperature and at the surface of concrete.

Notes:

1. For bridge decks, thermocouples shall be installed in sets of three consisting of one mid-depth thermocouple and two surface thermocouples. The surface thermocouples shall be placed immediately above or the shortest distance from the corresponding mid-depth thermocouple. The surface thermocouples shall be installed beneath the burlap, in contact with the surface concrete or imbedded in the concrete within 5 mm of the surface and, for bridge decks, the second surface thermocouple shall be placed inside the bottom form.

TABLE 3
Minimum Cold Weather Protective Measures

Footings and Slabs on the Ground				
Anticipated Minimum Ambient Air Temperature °C	Thickness			
	> 1.0 m	1.0 - 0.5 m	< 0.5 - 0.25 m	< 0.25 m
+5 to 0	PM1	PM1	PM1	PM2
-1 to -10	PM2	PM2	PM2	PM3
-11 to -20	PM3	PM3	PM4	PM5
less than -20	PM3	PM4	PM5	PM5
All Other Components				
+5 to 0	PM1	PM1	PM1	PM2
-1 to -10	PM2	PM2	PM3	PM4
-11 to -20	PM3	PM3	PM4	PM5
less than -20	PM4	PM5	PM5	PM5
Notes: A. Protective Measures PM1 - Cover components with a moisture vapour barrier as specified for curing with moisture vapour barrier. PM2 - Cover components as for PM1, then cover the moisture vapour barrier with insulation having an R-Value of 0.67. PM3 - Cover components as for PM1, then cover the moisture vapour barrier with insulation having an R-Value of 1.33. PM4 - Cover components as for PM1, then cover the moisture vapour barrier with insulation having an R-Value of 2.00. PM5 - Housing and heating. B. All R-Values are metric C. The conversion factor from metric to imperial units is: Metric R-Value x 5.678 = Imperial R-Value.				

TABLE 4
Maximum Allowable Drop in Concrete Temperature

Thickness	> 2.0 m	1.0 - 1.99 m	< 1.0 m
Maximum Allowable Drop in Concrete Temperature per 24 hours	10 °C	15 °C	20 °C

TABLE 5
Criteria for Treatment of Cracks

Components	Width of Crack at Widest Point mm	Treatment of Cracked Areas
Decks to be waterproofed and paved	≥ 0.50	Repair
Exposed decks	> 0.30	a) Repair cracks in the areas where total linear measurement of crack per m^2 is < 5 m. b) Remove and replace the cracked areas where total linear measurement of crack per m^2 is ≥ 5 m.
Barrier wall, parapet wall, sidewalk, and median on a structure	> 0.30	a) Repair cracks in the areas where the total linear measurement of crack per linear meter of the wall, sidewalk or median measured along the side facing traffic is < 5 m. b) Remove and replace the cracked areas where the total linear measurement of crack per lineal meter of the wall, sidewalk, or median measured along the side facing traffic is ≥ 5 m.
	≤ 0.30	Apply sealer acceptable to the ministry to cracked areas where total linear measurement of crack per m^2 is ≥ 5 m.
Curb on a structure	> 0.30	a) Repair cracks in the areas where the total linear measurement of crack per linear meter of the curb is < 1.5 m. b) Remove and replace the cracked areas where the total linear measurement of crack per linear meter of the curb is ≥ 1.5 m.
Piers, pier caps, abutments, and other structural components within 3 m of roadway	> 0.30	Repair
	≤ 0.30	Apply sealer acceptable to the ministry to cracked areas where total linear measurement of crack per m^2 is ≥ 5 m.
All other components	≥ 1.00	Repair

Appendix 904-A, November 2012
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

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

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Dowels. (904.05.13)
- Slope paving sealant installation. (904.07.04.05)
- Dowel type. (904.07.05.01)
- Installation of dowels. (904.07.05.02)
- Removal of formwork and falsework. (904.07.12)
- Location of construction joints. (904.07.13)
- Alignment of components. (904.07.15)
- Stressing strength for concrete. (904.07.16)
- Management of excess materials. (904.07.19)
- Payment adjustments for concrete. (904.10.01)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR STEEL REINFORCEMENT FOR CONCRETE

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APPENDICES

905-A	Commentary

905.01 SCOPE

This specification covers the requirements for the placement of steel reinforcement and mechanical connections for concrete structures.

905.01.01 Specification Significance and Use

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

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

905.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

905.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Material

OPSS 1440	Steel Reinforcement for Concrete
OPSS 1442	Epoxy Coated Steel Reinforcement for Concrete
OPSS 1443	Organic Coatings for Steel Reinforcement

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-M92 (R2002)	Billet Steel Bars for Concrete Reinforcement
S6-00 (R2005)	Canadian Highway Bridge Design Code
W186-M1990 (R2002)	Welding of Reinforcing Bars in Reinforced Concrete Construction

ASTM International

A 955/A 955M-05a	Deformed and Plain Stainless-Steel Bars for Concrete Reinforcement
E8/E8M-04	Standard Test Methods for Tension Testing of Metallic Materials

ISO International Organization for Standardization/International Electrotechnical Commission

ISO 17025 General Requirements for the Competence of the Testing and Calibration Laboratories

Others

Concrete Reinforcing Steel Institute:
Voluntary Certification Program for Fusion-Bonded Epoxy Coating Applicator Plants

905.03 DEFINITIONS

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

Coated Reinforcing Steel Bar means reinforcing steel bars coated with epoxy.

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

Mechanical Connection means a joining of two steel reinforcement bars by means of a mechanical connector.

Mechanical Connector means a mechanical device used to splice steel reinforcement bars.

Proposal means a Contractor's submission of changes, when engineering design is required, affecting the original design.

Reinforcing Stainless Steel Bars means as defined in OPSS 1440.

Reinforcing Steel Bars means as defined in OPSS 1440.

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 then unloaded to a bar stress of 5% of specified yield.

Splice means a connection of one steel reinforcement bar or splice bar to another by lapping, welding, mechanical connections, or other means or the lap between sheets or rolls of welded wire fabric.

Splice Bar means as defined in OPSS 1440.

Steel Reinforcement means a general term for deformed steel bars that includes reinforcing steel bars, splice bars, coated reinforcing steel bars, reinforcing stainless steel bars, and welded steel wire fabric.

Steel Wire Fabric means a wire mesh fabricated by means of welding the crossing joints, available in rolls or flat sheets.

Tensile Strength means the stress at which a steel reinforcement bar fails under tensile testing.

Yield Strength means the maximum tensile stress that a material is capable of sustaining.

905.04 SUBMISSION AND DESIGN REQUIREMENTS

905.04.01 Submission Requirements

905.04.01.01 Certification of Manufacturer

At least 3 weeks prior to fabrication, a statement shall be submitted to the Contract Administrator from the manufacturer certifying that their plant meets the minimum quality criteria set forth in the Voluntary Certification Program for Fusion-Bonded Epoxy Coating Applicator Plants document.

905.04.01.02 Working Drawings

When Working Drawings are not included in the Contract Documents by the Owner, the Contractor shall prepare and submit to the Contract Administrator 5 complete sets of Working Drawings consisting of steel reinforcement placing drawings and steel reinforcement schedules at least 3 weeks prior to commencement of the installation of the reinforcement. The Working Drawings shall include the following information:

- a) Quantity of steel reinforcement.
- b) Size of steel reinforcement bars.
- c) Grade of steel.
- d) Identification mark and number, including coating designation.
- e) Location and spacing for all steel reinforcement.
- f) Type of steel reinforcement.

When the Working Drawings have been prepared by the Contractor according to the Contract Documents, an Engineer's stamp is not required; however, the Working Drawings shall be accompanied by a letter bearing the seal and signature of an Engineer attesting to this conformity. All other design work requires the seals and signatures of both the design and the checking Engineers.

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. The submission shall include one additional set for each authority.

Work shall not commence until written notice to proceed has been given by the Contract Administrator.

When a metric to imperial bar size substitution is made, the Working Drawings shall include a), b), and c) as noted above, as well as the location and spacing of both the metric and the substitute imperial steel reinforcement bars.

When bar marks are shown on the Working Drawings, they shall be used in the schedule.

Reinforcing steel shall be detailed according to CAN/CSA-S6 and the Structural Manual.

905.04.01.03 Welding Details

Five copies of all welding details shall be submitted to the Contract Administrator at least 3 weeks prior to commencement of the welding of steel reinforcement. All welding details shall bear the seal and signature of an Engineer. The welding details shall include the following information:

- a) Materials.
- b) Procedures.
- c) Bars to be welded.
- d) Location and type of weld.
- e) Tack welds.

Details shall be designed to prevent notching effects in the bars.

905.04.01.04 Mechanical Connections

Five copies of all details for the mechanical connections shall be submitted to the Contract Administrator at least 3 weeks prior to commencement of the work and 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.

905.04.01.05 Mill Test Certificates

One copy of mill test certificates for each material to be used in the fabrication 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.

If the material cannot be identified by mill test certificates, coupons shall be taken and tested and these coupon test certificates shall be made available.

Two copies of the mill or coupon test certificates shall be submitted to the Contract Administrator when the material is shipped from the fabrication plant.

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 specified in the Contract Documents. The stamp shall include the appropriate material designation, testing date, and signature of an authorized officer of the Canadian laboratory.

905.04.01.06 Return of Submissions

Two copies of each submission to be returned shall be marked as one of the following:

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

In this case, work may commence upon receipt of the Working Drawing by the Contractor. A copy of these Working Drawings shall be available at the site prior to and during construction.

- b) Stamped with the wording that allows for permission to construct as noted.

In this case, work may start upon receipt of the Working Drawings by the Contractor. The Working Drawings shall be updated as noted and shall have a stamp affixed that is signed by an Engineer stating the Working Drawings have been revised according to the noted comments. A copy of the stamped updated Working Drawings shall be available at the site prior to and during construction.

- c) Showing only required changes.

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

905.05 MATERIALS

905.05.01 Steel Reinforcement

Steel reinforcement shall be according to OPSS 1440.

Reinforcement steel shall be produced by a manufacturer approved by the Owner.

The imperial and soft-converted metric bar size substitutions for metric bar sizes as shown in Table 2 shall be permitted on a one-for-one basis without adjustment.

Other imperial and soft-converted metric reinforcing stainless steel bar sizes may be substituted for metric bar sizes, subject to the following:

- a) The area of substituted steel reinforcement for the concrete component per linear metre or per gross cross-section area, as applicable, shall not be less than that shown for the concrete component on the Contract Documents.
- b) The spacing of substituted steel reinforcement for the concrete component shall be according to CAN/CSA-S6 and the Structural Manual.

Nominal cross-sectional areas of metric and imperial bar sizes used for determining substitutions shall be according to ASTM A 955M and CAN/CSA G30.18, respectively.

Reinforcing stainless steel bars, stainless steel spirals, and stainless steel spiral spacers shall be of a stainless steel type as shown in Table 1.

905.05.02 Mechanical Connections

The mechanical connectors shall be by a manufacturer acceptable to the Owner.

Mechanical connections for steel reinforcement shall develop in tension or compression, as required, at least 120% of the specified yield strength of the bars, but not less than 110% of the mean yield strength representative of the bars to be used in the test of the mechanical connection. For the purpose of qualifying mechanical connectors the actual yield strength obtained from the mill test certificate may be used in lieu of testing for the mean yield of the bars.

The total slip of the steel reinforcement shall not exceed the following measured displacements between gauge points straddling the mechanical connector as follows:

- a) For bar sizes up to and including 45M 0.25 mm

b) For 55M bars

0.75 mm

Splice bars shall be supplied by the manufacturer of the mechanical connector.

Mechanical connectors and splice bars for stainless steel reinforcing bars shall be of the stainless steel type as shown in Table 1.

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, or as specified in the Contract Documents.

905.05.03 Associated Hardware

Hardware, including spacers and support devices, approved by the Owner shall be used with steel reinforcement. Supports or support systems shall be capable of withstanding the loads to be placed on them. Embedded hardware, except for tie wire, within 50 mm of exposed faces shall be coated with an acceptable material or be of an acceptable non-metallic material.

The tie wire shall be annealed ferrous wire 2.6 mm in diameter and shall be coated when used with coated reinforcing steel bar.

Tie wire used to tie reinforcing stainless steel bars to reinforcing stainless steel bars, reinforcing steel bars, and shear studs shall be Type 316 LN or Type 316 L stainless steel wire, 1.2 or 1.6 mm in diameter. Tie wire used to tie reinforcing stainless steel bars to coated reinforcing steel bars shall be coated wire.

Concrete chairs shall be a minimum compressive strength of 20 MPa and may only be used in footings.

905.05.04 Patching Material for Coated Reinforcing Steel Bars

Patching material for coated reinforcing steel bars and mechanical connectors shall be according to OPSS 1443.

905.05.05 Polyethylene Sheeting

Polyethylene sheeting used for protection purposes shall be opaque and have a minimum thickness of 150 µm.

905.07 CONSTRUCTION

905.07.01 General

All reinforcement and associated hardware shall be kept clean of all mud, oil, and other deleterious materials that adversely affect bonding strength and stored clear of ground contact on timbers or other suitable protective cribbing spaced to prevent sags in the bundles.

Stacked bundles of straight bars shall have adequate blocking to prevent contact between the layers of bundles.

Reinforcing steel 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.

Reinforcing stainless steel bars shall be free of deposits of iron and non-stainless steels.

905.07.02 Reinforcing Steel Bars, Coated Reinforcing Steel Bars, Reinforcing Stainless Steel Bars, Splice Bars, Coated Splice Bars, and Stainless Steel Splice Bars

905.07.02.01 Storage and Protection of Coated Reinforcing Steel Bars

Unprotected on-site storage shall not exceed 30 Days and total on-site storage time shall not exceed 120 Days.

When protection is required, bars shall be covered with opaque polyethylene sheeting or other equivalent protective material. For stacked bundles, the protective covering shall be draped over the sides of the bundles around the perimeter of the stack. The covering shall be adequately secured with provisions for adequate air circulation around the bars to prevent condensation under the protective covering.

Exposed bars installed in the structure, including bars partially embedded in concrete, shall be protected from the elements by covering with opaque polyethylene sheeting or equivalent protective material when the exposure time exceeds 30 Days. The protection shall be adequately supported and secured in place.

This protection shall be maintained until removal is required for concrete placement.

905.07.02.02 Storage and Protection of Reinforcing Stainless Steel Bars

Reinforcing stainless steel bars shall be stored separately from other steel reinforcement with the bar tags maintained and clearly visible until placing operations commences.

905.07.02.03 Placing

Steel reinforcement shall be placed in the positions shown in the Working Drawings and held in this 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 spaced equally around the spiral and shall be such that the pitch of the spiral as specified in the Contract Documents is maintained.

Steel reinforcement shall be placed according to the tolerances as shown in Table 3.

905.07.02.04 Cutting

The cutting of steel reinforcement and splice bars, except for coated reinforcing steel bars and coated splice bars, by oxyacetylene torch may be carried out only where permitted in writing by the Contract Administrator. The cutting of coated reinforcing steel bars by oxyacetylene torch is prohibited. Coated bars shall be cut only when specified in the Contract Documents or approved by the Contract Administrator. Repairs to epoxy coatings shall be according to the Repairs to Damaged Epoxy Coating clause.

905.07.02.05 Bending

Steel reinforcement shall not be re-bent in the field, except when specified in the Contract Documents or approved by the Contract Administrator.

When epoxy coated reinforcing steel bars are re-bent or straightened in the field, the area of the bend shall be inspected and damaged areas repaired.

905.07.02.06 Welding

Steel reinforcement shall not be welded, including tack welds, except as shown in the Contract Documents or as shown on the welding details submitted to the Contract Administrator.

When welding of the steel reinforcement is specified in the Contract Documents, the welding shall be according to CSA W186 and performed by companies certified by the Canadian Welding Bureau according to CSA W186.

Welding of splices for coated reinforcing steel bar spirals shall be of the direct butt-splice type with no more than one splice per 15 m of bar. Splice welds shall be ground flush with the bar deformations and cleaned of deleterious material prior to application of the patching material. Patching of epoxy coating shall be according to the Repairs to Damaged Epoxy Coating clause.

Except for splicing of stainless steel spirals, stainless steel reinforcing bars shall not be welded.

905.07.02.07 Splicing

Welded splices shall develop 100% of the tensile strength of the bar.

Splices for steel reinforcement 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 as specified in the Working Drawings. Non-welded splices shall be by a mechanical connection 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 Repairs to Damaged Epoxy Coating

905.07.02.08.01 General

Coated reinforcing steel bars and associated hardware with epoxy coating damage greater than 1% of the surface area in any one metre length of bar shall be rejected.

Coated reinforcing steel bars and associated hardware with epoxy coating damage to 1% or less of their surface area shall have all damaged areas of the coating repaired.

Repairs to damaged epoxy coating shall be according to OPSS 1442.

Repairs shall not be done when the temperature of the steel bar or ambient air is 5 °C or less or when moisture is present on the bar.

905.07.02.08.02 Pre-Installation

Prior to installation, the Contract Administrator shall have access to inspect the coated reinforcing steel bars to identify bars to be rejected or repaired.

All bars and accessories with damaged portions of coating, including bare portions of bar, shall be repaired.

905.07.02.08.03 Post-Installation

After the coated reinforcing steel bars have been placed in the work, the Contract Administrator shall have access to inspect the coated reinforcement steel for visible signs of damage and to determine if steel with epoxy coating damage shall be replaced or repaired.

Repairs to the epoxy coating shall be completed at least 12 hours prior to permission to place concrete is given. Repairs should be performed immediately after the damage occurs and shall be done before rusting begins. Rust that is present shall be completely removed prior to the patching material is applied.

905.07.03 Mechanical Connections

905.07.03.01 General

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 mechanical connector manufacturer's recommendations.

Ends of reinforcing bars to be joined shall be cut nominally square.

Mechanical connector sleeves shall have the clear concrete cover as specified in the Contract Documents for the steel reinforcement in that location.

Stirrups, ties, and other reinforcement shall be adjusted or relocated, if necessary, to provide the required clear concrete cover to the reinforcement.

Threads cut on the ends of the steel reinforcement shall match the internal threads in the mechanical connector.

Joints between the coated reinforcing steel bars, coated splice bars, and coated mechanical connectors shall be sealed with the application of epoxy coating according to OPSS 1443. Epoxy coating shall be applied according to the manufacturer's recommendations.

905.07.03.02 Job Control Tests

When mechanical connectors are used, the Contractor shall perform job control testing on a lot by lot basis prior to installation of the connectors. A lot shall comprise of all connectors of one size and type from one supplier. The lot will be divided into sublots of 300 connectors or any fraction thereof. The job control test shall consist of testing for slip and strength according to LS-434. Testing shall be carried out on 3 sample connections for each subplot of mechanical connector types used in the Work. The samples shall be made at the Working Area in the presence of the Contract Administrator and the test shall be performed on each bar size connected.

Each test sample shall be tagged with a weatherproof marking that clearly identifies the following:

- a) Contract number.
- b) Sublot number.
- c) Connector bar size.
- d) Number of connectors within the sublot.
- e) Date of supply to the Working Area.
- f) Name of manufacturer.

The reinforcing bars from which the test samples are fabricated shall be selected on a random basis. 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 steel reinforcement in the work shall be used when making the sample connections.

The Contractor shall make sample connections and arrange testing by an independent test laboratory. The results shall be submitted to the Contract Administrator for his review and stamping.

When one of the 3 test samples for a sublot fails the slip test or the strength test, 2 new sample connections shall be prepared from the same sublot and tested along with the remaining connectors. In this case a total of 4 samples are necessary to qualify the sublot of 300. Qualification of this sublot requires all 4 connectors to pass. If these further requirements are not met, the sublot shall be rejected.

The above procedure shall be repeated for the next sublot. If an additional sublot fails, the remainder of the lot shall then be rejected and the Contractor shall submit a proposal for replacing this lot to the Contract Administrator for approval.

Only qualifying sublots shall be used in the work.

Rejected mechanical connections shall be stored at a secure site for inspection by the Contract Administrator until completion of the Work. After completion of the Work, the Contractor shall remove the rejected material.

A copy of all job control test reports bearing the seal and signature of an Engineer shall be submitted to the Contract Administrator.

905.07.03.03 Testing Laboratory Requirements

The testing of mechanical connectors shall be carried out by an independent laboratory accredited by the Standards Council of Canada or ISO 17025 registered for testing according to ASTM E8M.

905.07.04 Management of Excess Material

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

905.08 QUALITY ASSURANCE

905.08.01 Sampling

905.08.01.01 Steel Reinforcement

The sampling of steel reinforcement shall be on a random basis.

905.08.01.02 Reinforcing Stainless Steel Bar

Three 1.5 m long randomly selected samples of reinforcing stainless steel bars for each bar size from each supplier of reinforcing stainless steel bars shall be submitted to the Contract Administrator with the mill test certificates for that Contract.

905.08.02 Testing

905.08.02.01 Steel Reinforcement

The testing of steel reinforcement shall be according to CSA G30.18.

905.08.03 Mechanical Connections

The torque will be checked on 5% of the splices. Formwork that will limit access to connectors for testing purposes shall not be placed until testing has been completed.

905.09 MEASUREMENT FOR PAYMENT

905.09.01 Actual Measurement

**905.09.01.01 Reinforcing Steel Bar
Coated Reinforcing Steel Bar
Reinforcing Stainless Steel Bar**

Measurement of steel reinforcement shall be by mass for the steel reinforcement placed. Alternatively, steel reinforcement may be a lump sum item.

905.09.01.02 Mechanical Connections and Coated Mechanical Connections

For measurement purposes, a count shall be made of the number of mechanical connections or coated mechanical connections installed.

905.09.01.03 Stainless Steel Mechanical Connections

For measurement purposes, a count shall be made of the number of stainless steel mechanical connections installed.

905.09.02.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

905.10 BASIS OF PAYMENT

**905.10.01 Reinforcing Steel Bar - Item
Coated Reinforcing Steel Bar - Item
Reinforcing Stainless Steel 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.

Payment for the supply of steel reinforcement to the Working Area shall be made according to the Contract Documents.

When the Contract does not contain separate tender items for steel reinforcement, the Contract price for the concrete items into which the steel reinforcement is incorporated shall be full compensation for labour, Equipment, and Material to do the work.

**905.10.02 Mechanical Connections - Item
Coated Mechanical Connections - Item
Stainless Steel Mechanical Connections - Item**

Payment at the Contract price for the above tender items shall be full compensation for labour, Equipment, and Material to do the Work.

Costs associated with any required removal and replacement of rejected mechanical connectors shall be the Contractor's responsibility at no additional cost to the Owner.

TABLE 1
Type of Stainless Steel

Common or Trade Name	UNS Designation
Type 316 LN	S31653
Type 2205 Duplex	S31803
Note: A. Condition / Finish: reinforcing stainless steel bars and shapes shall be hot rolled and pickled or hot rolled and descaled to the required mechanical properties and dimensions.	

TABLE 2
Metric to Imperial Steel Reinforcement Bar Size Conversion

Metric Bar Size	Imperial Bar Size	Bar Designation No.
15M	#5	15
25M	#8	25
35M	#11	35

TABLE 3
Tolerances for Cover and Placing Accuracy

Steel Reinforcement	Tolerance mm	
Location	Cast-In-Place Concrete	Precast Concrete
Cover To Surface of Concrete (Note 1)		
Principal Reinforcing Steel	± 20	± 10
Concrete Cast Against and Permanently Exposed to Earth	± 25	
Stirrups in Webs		+ 5, - 3
Stirrups, Ties, Spirals	± 20	± 10
Placing Accuracy		
Thin Deck Slab Top Bottom	± 20 ± 10 (Notes 2, 3, and 4)	± 15 ± 10 (Notes 2, 3, and 4)
Remainder	± 30 (Notes 2, 3, and 4)	± 30 (Notes 2, 3, and 4)
Lateral Spacing in Thick Slabs, Footings and Walls	± 30 (Notes 3 and 4)	± 30 (Notes 3 and 4)
Longitudinal Location of Bends and Ends of Bar in Continuous Member	± 50	± 50
Longitudinal Location of Bends and Ends of Bar at Discontinuous End	± 20	± 20
Notes: Notwithstanding the above tolerances: 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. 3. In 2 or more layers, the rebar shall be directly above one another and the clear distance between layers shall not be less than 25 mm. 4. The size, number, and spacing of bars shall be as specified in the Working Drawings.		

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

The designer should specify the following in the Contract Documents:

- Pitch of spiral steel reinforcement. (905.07.02.03)
- Concrete cover to steel reinforcement connections. (905.07.03.01)
- Payment for supply of steel reinforcement to working area. (905.10.01)

The designer should determine if any of the following are required and, if so, specify them in the Contract Documents.

- Whether the Owner is supplying the Working Drawings. (905.04.01.02)
- Whether the need for a specific type of mechanical connector. (905.05.04)
- Whether cutting of coated bars is allowed. (905.07.02.04)
- Whether field re-bending of bars is allowed. (905.07.02.05)
- Whether welding of steel reinforcement is allowed. (905.07.02.06)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 804.030	Concrete Headwall For Pipe Less Than 900 mm Diameter
OPSD 804.040	Concrete Headwall For Sewer Or Culvert Pipe Outlet
OPSD 812.010	Cut Off Wall For Structural Plate Pipe Arch Or Circular CSP
OPSD 3329.100	Deck, Reinforcement Supports For Reinforcing Steel For Slab Depths Less Than 300 mm
OPSD 3329.101	Deck, Reinforcement Supports For Reinforcing Steel For Slab Depths Greater Than 300 mm
OPSD 3339.100	Deck, Voids Access Hatch For Concrete Bridges Installation



CONSTRUCTION SPECIFICATION FOR METAL TRAFFIC BARRIERS AND METAL RAILINGS FOR STRUCTURES

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

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

908.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

908.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 906 Structural Steel

CSA Standards

G40.20/G40.21-04 (R2009)	General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steels
G164-M92 (R2003)	Hot Dip Galvanizing of Irregularly Shaped Articles
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
G189-1966 (R2003)	Sprayed Metal Coatings for Atmospheric Corrosion Protection

ASTM International

A 27/A 27M-08	Specification for Steel Castings, Carbon, for General Application
A 307-07b	Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength
A 314-08	Specification for Stainless Steel Billets and Bars for Forging
A 325M-09	Standard Specification for Structural Bolts, Steel, Heat Treated 830 MPa Minimum Tensile Strength [Metric]
A 780/A 780M-09	Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings

B 108M-08	Specification for Aluminum-Alloy Permanent Mold Castings
B 117-09	Standard Practice for Operating Salt Spray (Fog) Apparatus
B 209-07	Specification for Aluminum and Aluminum-Alloy Sheet and Plate
B 221-08	Aluminum and Aluminum-Alloy Extruded Bars, Rod, Wire, Shapes and Tubes
D 4541-09	Test Methods for Pull-Off Strength of Coatings Using Portable Adhesion Testers

Canadian General Standards Board (CGSB)

CAN/CGSB-1.181-99 Ready-Mixed Organic Zinc-Rich Coating

Society for Protective Coatings (SSPC)

SSPC - SP 1, November 2004 Solvent Cleaning

SSPC - SP11, November 2004 Power Tool Cleaning to Bare Metal

U.S. General Services Administration:

FED-STD-595C-Jan. 16, 2008 Colors Used in Government Procurement

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.

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

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 railing manufacturer shall not commence fabrication of the railing 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

Upon completion of fabrication, the Quality Verification Engineer shall conduct an interim inspection of the work to verify that the fabrication of the railing has been carried out according to the railing Working Drawings and as specified in the Contract Documents, and issue written permission to proceed with the delivery.

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.

Cast steel posts shall be according to ASTM A 27, Grade 65-35.

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.

All steel surfaces shall be protected by hot dipped galvanizing according to CAN/CSA G164-M, providing a minimum zinc mass of 610 g/m².

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 CAN/CSA G164-M.

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 Zinc Rich Paint

Zinc rich paint shall be according to CAN/CGSB-1.181.

908.07 CONSTRUCTION

908.07.01 General

Railing components shall be protected from damage and distortion during handling, transportation, storage, and installation.

Bedding grout shall not be used. Epoxy grout can be placed under post bases, as necessary, to fill the voids. The epoxy grout shall not have a thickness exceeding 3 mm. The mixing, surface preparation, installation, and curing 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 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 Anchorages 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 Anchorages Installed in Timber

Holes for bolts shall be drilled with a bit 1.5 mm larger in diameter than the bolt. The diameter of the recessed holes for the bolt heads shall be no greater than 10 mm larger than the width of the bolt head.

Where oil treatment has been used on the wooden curbing, the cut surfaces of the wood shall be given three coats of creosote oil. Each coat shall be allowed to dry before the next coat is applied.

Repairs to cuts in material treated with water-borne preservatives shall be according to CSA O80 Series.

908.07.04 Fabrication of Railings

908.07.04.01 General

The railing system 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

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.

When the galvanized surface of a railing 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 CAN/CSA G164-M.

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.

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) Repair by epoxy zinc/epoxy/polyurethane paint system

This method of repair of galvanized coating is permitted when:

- i. The individual damaged and uncoated area with exposed steel is less than 625 mm².
- ii. The dry film thickness of the galvanized (zinc) coating of a structural member in localized areas does not meet the specification requirements but exceeds 60 µm.
- iii. The number of repair spots does not exceed 6 per each 12 m section of galvanized rail bar. The number of repair spots in each galvanized rail post shall be limited to a maximum of 2.

Repair of galvanized coating defects on railings and posts shall be made with coating material from the MTO's pre-qualified products list or, when specified in the Contract Documents, the Owner's pre-qualified products list.

- i. Structural coating material shall be low volatile organic compounds (VOC).
- ii. All three listed coatings shall be from the same manufacturer applied in the correct order.
- iii. The colour of the finish coat shall be equivalent to 17178 aluminum according to FED-STD-595C.

Surface preparation for repairing by this procedure requires hand or power tool cleaning of the damaged or uncoated area using clean equipment, scraping of the edges of metal coating to remove loose edges, and feathering of the edges of intact coatings and abrading of surface, followed by

solvent cleaning according to SSPC-SP 1. Where damage has exposed 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 for repair shall be brush applied according to the manufacturer's product data sheets.

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

The design should specify the following in the Contract Documents:

- Steel Grade 350W or 350WT for rails and posts. (908.05.02.01)
- Steel Grade 300W or 350W for steel plate. (908.05.02.01)
- Galvanized bolts and nuts: ASTM A 307 or ASTM A 325M. (908.05.02.01)
- Paint for steel railing steel posts. (908.05.02.01)
- Anchorage assembly requirements. (908.05.03)
- Detailed grout requirements. (908.05.04)
- Railing elevations and alignments. (908.07.02)
- Anchorage assembly installation. (908.07.03.01)

The design should determine if the following are required and, if so, specify them in the Contract Documents:

- Anchorage to be installed prior to concrete placement. (908.07.03.02)
- Anchorage to be installed after concrete placement. (908.07.03.03)
- Coating materials from Owner's pre-qualified products list. (908.07.04.02)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 3419.100	Barriers and Railings, Steel Beam, Guide Rail and Channel Anchorage
OPSD 3419.150	Barriers and Railings, Steel, Single Railing Anchorage
OPSD 3419.155	Barriers and Railings, Steel, Double Railing Anchorage



**ONTARIO
PROVINCIAL
STANDARD
SPECIFICATION**

**METRIC
OPSS.MUNI 909
NOVEMBER 2016**
(Formerly OPSS 909, April 2012)

Note: The MUNI implemented in November 2016 replaces OPSS 909 COMMON, April 2012 with no content changes.

**CONSTRUCTION SPECIFICATION FOR
PRESTRESSED CONCRETE - PRECAST MEMBERS**

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909.01	SCOPE

This specification covers the construction requirements for fabrication, delivery, and erection of concrete members with steel reinforcement.

909.01.01 Specification Significance and Use

This specification has been developed for use in provincial- and municipal-oriented Contracts. The administration, testing, and payment policies, procedures, and practices reflected in this specification correspond to those used by many municipalities and the Ontario Ministry of Transportation.

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

909.01.02

Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

909.02

REFERENCES

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

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 904	Concrete Structures
OPSS 905	Steel Reinforcement for Concrete
OPSS 910	Stressing Systems for Post Tensioning
OPSS 919	Formwork and Falsework
OPSS 929	Abrasive Blast Cleaning - Concrete Construction

Ontario Provincial Standard Specifications, Material

OPSS 1002	Aggregates - Concrete
OPSS 1213	Hot Applied Rubberized Asphalt Waterproofing Membrane
OPSS 1350	Concrete - Materials and Production
OPSS 1440	Steel Reinforcement for Concrete
OPSS 1442	Epoxy Coated Steel Reinforcement for Concrete

Ontario Ministry of Transportation Publications

MTO Laboratory Testing Manual:

- LS-407 Method of Test for Compressive Strength of Moulded Cylinders
- LS-426 Method of Test for Compressive Strength of High Performance Concrete Cylinders
- LS-432 Method of Test for Microscopical Determination of Air Void System Parameters in Hardened Concrete
- LS-433 Method of Test for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration

Structural Manual

MTO Form:

PH-CC-322 Concrete Construction Report

CSA Standards

- A23.2-3C Making and Curing Concrete Compression and Flexural Test Specimens *
 - A23.2-1D Moulds for Forming Concrete Test Cylinders Vertically *
 - A23.4-09 Precast Concrete Material and Construction
 - G40.20/G40.21-04 General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel
 - G164-M92 (R2003) Hot Dip Galvanizing of Irregularly Shape Articles
 - G189-1966 (R2003) Sprayed Metal Coatings for Atmospheric Corrosion Protection
 - S6-06 Canadian Highway Bridge Design Code
 - W47.1-09 Certification of Companies for Fusion Welding of Steel Structures
 - W59-03 (R2008) Welded Steel Construction (Metal Arc Welding)
 - W186-03 (R2007) Welding of Reinforcing Bars in Reinforced Concrete Construction
- * [Part of A23.1-09/A23.2-09 - Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete]

ASTM International

- B 633-07 Electrodeposited Coatings of Zinc on Iron and Steel
- C 171-07 Sheet Materials for Curing Concrete

American Association of State and Highway Transportation Officials (AASHTO)

- M182-05 (2009) Burlap Cloth made from Jute or Kenaf and Cotton Mats

909.03 DEFINITIONS

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

Bed means the assembly consisting of platform, forms and end blocks in which the members are cast.

Certificate of Conformance means a 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.

Design Proposal means a Contractor's submission of proposed changes, when engineering design is required.

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

Laitance means a layer of weak and nondurable material on the surface of the concrete containing cement and fines from aggregates, brought by bleeding water to the top surface concrete.

Lot means all the members of the same member type, cast during 7 consecutive Days.

Member means a precast concrete prestressed girder.

Member Type means a member differentiated by its cross-section shape such as Box, I, or T.

Post-Tensioning means a method of prestressing in which tendons are tensioned after the concrete has reached a predetermined strength.

Precaster means the party who produces the members.

Prestressed Concrete means reinforced concrete in which internal stresses have been initially introduced so that subsequent stresses resulting from dead load and superimposed loads are counteracted to a desired degree. This may be accomplished by pretensioning or post-tensioning.

Pretensioning means a method of prestressing in which tendons are tensioned before the concrete is placed.

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

Repair Proposal means a Contractor's submission when repairs to the members are required.

Strand means a group of wires laid helically over a central core-wire.

Sweep means the lateral deviation from straightness of a member with respect to its design centre line.

Tendon means a high strength steel element consisting of one or more wires, strands or bars; used to impart prestress to the concrete.

909.04 DESIGN AND SUBMISSION REQUIREMENTS

909.04.01 Design Requirements

909.04.01.01 General

The design shall be according to CAN/CSA S6 and the Structural Manual.

909.04.01.02 Permissible Changes from the Contract Drawings

909.04.01.02.01 General

Changes from the Contract Drawings are permitted and may be implemented by the precaster, without prior approval from the Owner, provided they meet the requirements of this specification.

909.04.01.02.02 Permissible Changes to Prestressing of Members

The prestressing strand pattern may be adjusted to suit production requirements provided all changes meet the original design strength without adversely affecting other components of the structure. If the centre of gravity of the strands at the interior hold down closest to mid-span is within ± 10 mm of the original design, then one or more of the following adjustments shall be permitted provided that both the serviceability and ultimate limit states capacities are not adversely affected:

- a) Provide additional strands with a lower jacking stress provided the total prestress force is within $\pm 2\%$ of the original design.
- b) Use of imperial strand spacing in lieu of metric, where 25 mm = 1" and 50 mm = 2".
- c) Addition of one hold-down per end is added towards the member end at the same spacing as the original design.
- d) One less hold-down per end when the hold-down closest to mid-span is deleted.
- e) Increase or decrease the number of strands in each hold-down group.
- f) Increase of vertical strand spacing between hold-down points from 25 mm up to 50 mm.

909.04.01.02.03 Permissible Changes to Reinforcing of Members

The stirrup projection may be adjusted from that shown on the original design, based on details such as the predicted camber, provided it meets the deck embedment range indicated elsewhere in the Contract Documents.

Spacing of stirrups around blockouts for diaphragms may be adjusted, as long as the minimum spacing requirements of CAN/CSA S6 are satisfied, and up to two stirrups may be added in order to maintain the total reinforcement requirements.

909.04.01.02.04 Other Design Details

Details limited to those below may be adjusted to suit production requirements, provided all changes meet the original design without adversely affecting other components of the structure:

- a) Dowel holes and inserts may be adjusted vertically within ± 75 mm from the location shown on the original design to avoid any conflict with tendons.
- b) Undercut dimensions may be adjusted to accommodate the predicted camber.
- c) Additional pockets and hardware for temporary bracing may be added.
- d) Additional temporary post-tensioning or pre-tensioning for shipping and handling may be added provided they do not adversely affect the girders at any stage.

The production length of the member may be adjusted to account for elastic shortening.

909.04.01.03 Temporary Bracing

Temporary bracing for members shall be designed according to CAN/CSA S6 using a wind load specific for the location and having a return period of 10 years if the members are to be permanently connected within the same construction season. If the members are not to be permanently connected within the same construction season, the return period to be used in the design shall be 25 years.

909.04.02 Submission Requirements

909.04.02.01 Working Drawings

The Contractor shall submit 3 sets of fabrication Working Drawings, including supporting documentation, to the Contract Administrator at least 7 Days prior to commencement of fabrication of the members, for information purposes only. Prior to making a submission, the design Engineer and the design-checking Engineer shall affix their seals and signatures on the Working Drawings verifying that the drawings are consistent with the Contract Documents.

When other authorities are involved in the approval of the design or construction of a highway structure, submissions shall be made at least 5 weeks prior to commencement of work and one additional copy of the submission shall be provided for each authority. The requirements of each authority and the Owner, as stated elsewhere in the Contract Documents, shall be satisfied prior to commencement of the Work.

The Working Drawings shall include the following information:

- a) Member details.
- b) Prestressing reinforcing steel size, grade, location, and jacking force as required by the design.
- c) Hold-down locations and forces.
- d) Reinforcing steel schedules.
- e) Lifting point locations.
- f) Details and location of all temporary supports.
- g) All other applicable details.

The supporting documents shall include the following information:

- a) A letter signed and sealed by an Engineer listing all permitted changes made along with supporting calculations. The letter shall state that the changes have not adversely affected the member capacities.
- b) Handling and erection procedures, including calculations and lifting point locations.
- c) Details of bracing installed to provide adequate support and stability to the member during construction.

909.04.02.02 Concrete Mix Design

The Contractor shall be responsible for the concrete mix design and shall submit the concrete mix design to the Contract Administrator according to the mix design requirements of OPSS 1350.

909.04.02.03 Concrete Plant Certification

The precast concrete plant certificate verifying compliance with the certification requirements of the Canadian Standards Association (CSA) under the category Precast Concrete Products-Structural, Prestressed; or the Canadian Precast/Prestressed Concrete Institute (CPCI), Group B, Products and Group BA, Bridge Products with Architectural Finishes, Category B4, shall be submitted to the Contract Administrator as part of the concrete mix design submission.

Documentation verifying certification of the concrete production facility by the Ready-Mixed Concrete Association of Ontario shall be submitted when concrete is supplied by an external concrete supplier.

909.04.02.04 Control of Concrete Temperature

One week prior to the commencement of fabricating the members, a description of the method for monitoring and effectively controlling the temperature of the concrete shall be submitted to the Contract Administrator, for information purposes only. The description shall include the method of controlling the concrete temperature during the curing and protection period.

909.04.02.05 Precast Report

A precast report shall be submitted to the Contract Administrator for each shipment of members, prior to shipping the members. The report shall contain the following information:

- a) List of members in the shipment, including their ID number and description.
- b) The mill certificates for the strands, along with the elongation calculations based on the actual material properties specified in the mill certificate of the strands used in the work.
- c) Record of the jacking force, elongations, and corrections used for temperature variation.
- d) Temperature control records, including location of thermocouple wires.
- e) Summary of material test results for plastic concrete: air content, slump, and concrete temperature.
- f) Summary of material test results for hardened concrete: transfer strength, confirmation of the projected 28-Day compressive strength, and air void system parameters. If test results are not available at the time of shipping, they may be submitted within 4 Business Days following completion of testing.
- g) Summary of all measurements and inspections required herein, including the concrete cover, crack measurement summary, tolerances, and surveys for geometric control.
- h) Documentation that the Contractor identified, evaluated, and corrected all repairable defects, as detailed under the clause on Repair of Defects and Deficiencies Repairable by Standard Methods.
- i) A letter from the Quality Verification Engineer (QVE), giving the Contractor permission to proceed with the work. The letter shall state that the QVE has conducted an interim inspection and verified that the fabrication of members and required testing have been carried out in general conformance with the sealed and signed Working Drawings, supporting documents, and Contract Documents.

909.04.02.06 Design Proposals

Five copies of the design proposal shall be submitted to the Contract Administrator for acceptance. The design proposals shall bear the seal and signature of the design Engineer and the design checking Engineer. The Contractor shall not proceed with the proposed changes until the design proposal has been accepted by the Contract Administrator.

The Contract Administrator shall respond to the Contractor within 10 Business Days of receiving the proposal.

909.05 MATERIALS

909.05.01 Bearing Plate

The bearing plate shall meet the requirements of CSA G40.20/G40.21, Grade 300W or greater.

Anchor studs shall be a headed type and meet the requirements of CSA W59 M and shall be welded to the bearing plates prior to galvanizing.

All surfaces shall be hot dipped galvanized and meet the requirements of CAN/CSA G164 or shall be zinc metallised according to CSA G189.

909.05.02 Burlap

Burlap shall be according to AASHTO M182, Class 4, and shall be free from substances that are deleterious to concrete. The burlap shall have no tears or holes.

909.05.03 Concrete

Concrete materials and production shall be according to OPSS 1350 with the following exceptions and amendments:

- a) Compressive strength shall be as specified in the Contract Documents.
- b) The air void system in hardened concrete when tested according to LS-432 shall be:
 - i. Air Content: 3.0% minimum
 - ii. Spacing Factor: 0.200 mm maximum
- c) Rapid chloride permeability of concrete containing silica fume at 28 to 32 Days shall be equal to or less than 1,000 coulombs and rapid chloride permeability of all other concrete at 28 Days shall be equal to or less than 2,500 coulombs.
- d) Aggregates shall be according to OPSS 1002 with the exception that the maximum nominal size of coarse aggregate shall not exceed 19.0 mm.
- e) Slag aggregate shall not be used.
- f) Superplasticizer may be added to the mix at time of batching for all types of concrete.

909.05.04 Concrete Sealers

Concrete sealers shall be from the Owner's list of acceptable sealers.

909.05.05 Elastomeric Coating

Elastomeric Coating shall meet the requirements of OPSS 1213.

909.05.06 Formwork

All formwork shall be according to OPSS 919 and CAN/CSA A23.4. Forms shall be fabricated to meet the dimensional tolerances and finishes required herein.

909.05.07 Hardware

All hardware shall be non-corroding or be galvanized according to CAN/CSA G164.

The hold down device may be black steel, however, the surfaces of the hold down device located within 40 mm of the concrete surface shall be chromate coated over an electrodeposited coating of zinc according to ASTM B 633.

909.05.08 Moisture Vapour Barrier

The moisture vapour barrier shall be a white opaque polyethylene film according to ASTM C 171 and shall not be less than 100 µm thick.

909.05.09 Post-Tensioning Material

Post-tensioning material, including grout shall be according to OPSS 910.

909.05.10 Proprietary Patching Materials

Proprietary patching materials shall be from the Owner's pre-qualified list of concrete patching materials. The list of proprietary patching material shall be obtained from the Contract Administrator.

909.05.11 Steel Reinforcement

Steel reinforcement shall be according to OPSS 905, OPSS 1440, and OPSS 1442.

909.05.12 Strand Splices

Strands shall not be spliced.

909.06 EQUIPMENT

909.06.01 Chipping Hammers

Chipping hammers shall have a maximum weight of 9.0 kg and a maximum piston stroke of 102 mm. All hammers shall have the manufacturer's name and model number engraved on them by the manufacturer. All information must be legible.

909.06.02 Pretensioning and Post-Tensioning

Pretensioning equipment shall be according to CSA A23.4. Post-tensioning equipment shall be according to OPSS 910.

909.06.03 Thermocouples and Dataloggers

Thermocouples and associated instrumentation shall have an accuracy of ± 1.5 °C and shall be capable of recording temperature and instantaneously displaying the temperature.

909.07 CONSTRUCTION

909.07.01 General

The Contractor shall notify the Contract Administrator in writing at least 7 Days prior to commencement of fabrication.

Each member shall be identified with a unique number and the date of casting. The information shall be marked on the members and shall remain visible for the duration of construction. When the information is stencilled, indelible ink or paint shall be used.

909.07.02 Precast Plant Certification

Members shall be fabricated by a plant certified by the Canadian Standards Association (CSA) under the category Precast Concrete Products-Structural, Prestressed; or by the Canadian Precast/Prestressed Concrete Institute (CPCI), Group B, Products and Group BA, Bridge Products with Architectural Finishes, Category B4.

909.07.03 Pretensioning

Tendons shall not be tensioned in the deflected position, unless the hold-down device used permits free movement of the strand and the use of the device has been tested by its manufacturer to ensure that the final stress along the full length of the tendon is uniform.

909.07.04 Welding

Welding of steel hardware including shear studs shall be according to CSA W59 and shall be performed by a qualified welder working for a company certified by the Canadian Welding Bureau according to CSA W47.1.

Welding of reinforcing steel bars shall be according to CSA W186 and performed by a qualified welder working for a company certified by the Canadian Welding Bureau according to CSA W186.

909.07.05 Steel Reinforcement

The placement of steel reinforcement shall be according to OPSS 905, with the exception or addition or both of the placing tolerances listed below:

- a) Vertical position of prestressing tendons: + 5/-10 mm
- b) Length of debond on prestressing tendons: ± 50 mm
- c) Projection of positive moment connection reinforcing steel at girder ends: ± 25 mm
- d) Stirrup spacing: ± 15 mm when spacing is 100 mm or less
 ± 25 mm when spacing is greater than 100 mm
 ± 30 mm when spacing is 300 mm or greater

909.07.06 Formwork

Formwork shall be according to OPSS 919.

909.07.07 Placing of Sheaths and Anchorages

When members are to be post-tensioned, the sheaths and anchorages shall be placed according to OPSS 905 except that the placing tolerances shall be ± 5 mm at splice points and ± 10 mm elsewhere.

909.07.08 Placing Concrete

The temperature of formwork, steel reinforcement, or the material on which the concrete is to be placed shall not exceed 30 °C.

The placing of concrete shall be according to OPSS 904, with the exception that the temperature of the formwork, steel reinforcement, or the material on which the concrete is to be placed shall be at a minimum temperature of 5 °C, prior to the placing operation. After discharging of concrete has started, one addition of superplasticizer shall be allowed, provided there is sufficient remaining time for mixing and testing. The slump and air content shall be re-tested if the mix is re-dosed.

During the placing operation, all exposed concrete surfaces shall be covered with water saturated burlap, within 2 to 4 m of the concrete reaching the top of the forms.

909.07.09 Concrete Finishing

The top surface of prestressed members, against which new concrete is to be placed, shall be intentionally roughened while it is sufficiently plastic so that the depth of the indentations is at least 5 mm and the spacing is not greater than 15 mm.

All concrete surfaces against which new concrete is to be placed shall be clean, sound, and free from any loose particles and laitance.

The following surfaces shall be abrasive blast cleaned according to OPSS 929, prior to shipping the members:

- a) Top portion of members containing laitance.
- b) The portion of the sides and end of the member against which new concrete is to be placed.

909.07.10 Control of Temperature

During production and during moist curing, moisture retention, and protection periods, the following temperature requirements shall be met:

- a) The concrete temperature shall not exceed 70 °C.
- b) The concrete temperature shall not fall below 10 °C before the concrete has reached 75% of the specified 28-Day compressive strength.
- c) The temperature difference between the concrete temperature of the member, and the conditions to which it is to be exposed shall not exceed 20 °C along any part of the member.

909.07.10.01 Temperature Records

Thermocouples, data loggers, handhelds units, and associated hardware shall be used to monitor the temperature of the member and the ambient conditions to which the member is exposed.

A sufficient number of thermocouples and thermocouple wires shall be installed to ensure compliance with the standard. As a minimum, thermocouples shall be installed to measure the following:

- a) Air temperature that the member is exposed or is to be exposed to.
- b) Concrete temperatures at the following locations:

For I-members

- i. In the middle of the web, 1 m from each end of the member.
- ii. In the middle of the web at mid-span.
- iii. In the middle of the bottom flange at mid-span.

For Box-members

- i. In the middle of the solid section at each end of the member.
- ii. In the middle of the bottom slab at mid-span.

Recording of the concrete temperatures shall begin at the start of the placing operation and continue until the moist curing, moisture retention, and protection periods are complete. For each member, the listed temperatures shall be recorded at intervals of 30 minutes or less.

The Contract Administrator shall be provided with necessary access, instrumentation, and equipment to verify temperature readings instantaneously. The thermocouples and data loggers shall be left in place until the end of the monitoring period.

909.07.11 Curing and Protection

909.07.11.01 Curing - General

Moist curing shall be applied for 48 hours followed by a 48-hour moisture retention period.

Concrete containing silica fume shall be moist cured for 7 Days, regardless of the ambient conditions.

During the moist curing and moisture retention period, the members may be exposed to ambient conditions for no more than a cumulative total of 3 hours for the purposes of form removal, release of strands at transfer strength, filling of bug holes, inspection, removal from the bed, and storage.

909.07.11.02 Moist Curing

During the first 48 hours after concrete placement, exposed surfaces shall be moist cured by any of the methods described below.

- a) Saturated burlap.
- b) Water spray or misting.
- c) Steam.
- d) Other means of maintaining 100% relative humidity next to the concrete surface.

Surfaces covered by the forms are not considered exposed. If forms are removed within the first 48 hours, all concrete surfaces shall be immediately moist cured by the positive addition of moisture for the duration of the 48 hours, according to the methods noted above.

Spray or steam to raise the ambient temperature above 30 °C, shall not be applied until after the concrete has attained its initial set. Steam, heat, or forced air shall not be directed on the concrete, forms, reinforcing steel or tendons. There shall be free circulation of steam, heat, and forced air around the top, sides, and ends of the members. The members shall be heated evenly. Concrete surfaces shall not be exposed to combustion gases.

All water shall be removed from and precautions taken to prevent the re-entrance of water into, the sheaths or any internal voids.

909.07.11.03 Moisture Retention

After moist curing has been completed, member surfaces shall be completely covered by moisture vapour barrier to protect members from moisture loss for a period of 48 hours.

At the option of the Contractor, moist curing methods may be continued during this period.

909.07.11.04 Protection from Cold

Prior to full exposure and after the moist curing and moisture retention periods, members that are to be exposed to temperatures less than 5 °C shall be protected from moisture loss for a minimum of an additional 3 Days. The protection period shall be extended beyond 3 Days, if required to meet the Control of Temperature clause.

All members must be dry prior to exposing them to temperatures below 0 °C.

909.07.12 Transfer of Prestressing Force

The prestressing force shall not be transferred to the members until the transfer strength specified in the Contract Documents has been reached. The prestressing force shall be transferred gradually and in a sequence that ensures eccentricities are kept to a minimum.

909.07.13 Treatment at Ends of Members

The prestressing tendons at ends of members that are to be encased in concrete shall be cut off 25 mm beyond the ends of the beams. The prestressing tendons at the end of members that are not to be encased in concrete shall be cut back to recess the cable 25 mm from the end of member. The recess shall be cleaned, filled with a proprietary patching material, and the ends of the members coated with elastomeric coating.

909.07.14 Quality Control

909.07.14.01 General

The Contractor shall carry out sufficient quality control testing and inspection to ensure that the concrete meets the requirements of the Contract Documents.

909.07.14.02 Sampling and Testing of Plastic Concrete

The Contractor shall be responsible for all aspects of sampling and testing of the plastic concrete for slump, air content, and temperature according to OPSS 1350. The results of these tests shall be recorded. The minimum frequency of testing shall be at least once for each load of concrete delivered by a truck mixer, or once for every 7 m³ of concrete for non-truck mixers until satisfactory control is established.

Satisfactory control is established when three consecutive tests of concrete are within the specified requirements, without field adjustments. If any field adjustments are required, testing shall continue until three consecutive tests meet the requirements with no field adjustments.

After satisfactory control has been established, testing shall be carried out on every third load delivered by a truck mixer, or at a delivery frequency of 21 m³ of concrete for non-truck mixers.

Sampling and testing of slump, air content, and temperature of plastic concrete, and casting of cylinders for determination of hardened concrete properties shall be carried out by a person holding either of the following certifications:

- a) CCIL Certified Concrete Testing Technician
- b) ACI Concrete Field Testing Technician, Grade 1

The person shall have a valid original card issued by the certifying agency in his or her possession at all times.

909.07.14.03 Transfer Strength

The Contractor shall demonstrate that the transfer strength specified in the Contract Documents has been achieved prior to transfer of prestressing force.

The Contractor, when requested by the Owner, shall participate in standard cylinder correlation strength testing programs conducted by the Ministry of Transportation.

909.07.14.04 Concrete Cover Measurement

The Contractor shall carry out, at the precaster's facility, a cover meter survey on all members until satisfactory control is established. For each lot, satisfactory control shall be established when three consecutive members of the same design are within the specified tolerances. After satisfactory control has been established, testing shall be carried out on every fifth member. If testing indicates that cover measurements for a member do not meet the tolerances specified in Table 1, testing shall resume on each member until satisfactory control is re-established.

Readings shall be taken at locations 300 mm from both ends, at mid-span, and at intervals not exceeding 5 metres along the length of the member.

For I-members, readings shall be taken at each location, as detailed below:

- a) Top of web, both sides.
- b) Bottom of web, both sides.
- c) Mid-height of each side of bottom flange.
- d) Underside of member, located at 150 mm from both edges of flange.

For box members, readings shall be taken at each location, as detailed below:

- a) Top of web, exterior sides.
- b) Bottom of web, exterior sides.
- c) Underside of member, located at 400 mm from both edges of flange.

909.07.14.05 Dimensional Measurements

The Contractor shall carry out measurements on each member to determine compliance with tolerance requirements. Members shall meet the tolerances specified in Table 1.

909.07.15 Sampling for Quality Assurance

Concrete shall be sampled on a lot basis.

909.07.15.01 General

The Contractor shall be responsible for all aspects of preparation, storage, and transportation of cylinders to determine compressive strength, air void system parameters, and rapid chloride permeability. Cylinders shall be 100 mm in diameter and 200 mm long. Samples shall be taken after all field adjustments have been made to the load of concrete.

Concrete cylinders shall be cast, cured, handled and transported according to CSA A23.2-3C. The specimens shall be delivered to the ministry's regional quality assurance laboratory, as directed by the Contract Administrator.

Moulds shall be according to CSA A23.2-1D, with a lid. The lids shall be chemically and physically compatible with the concrete and shall provide a watertight seal for the moulds.

909.07.15.02 28-Day Compressive Strength

The Contractor shall cast one set of acceptance and at his discretion cast one set of referee cylinders for each lot. Both sets of cylinders shall be cast from the same batch of concrete.

One set shall consist of three cylinders.

Test information shall be recorded on MTO form PH-CC 322. The forms shall be submitted with the concrete cylinders.

909.07.15.03 Air Void System and Rapid Chloride Permeability

The Contractor shall cast 1 cylinder from each lot for determination of air void system parameters of hardened concrete and 2 cylinders from each lot for determination of rapid chloride permeability. Each cylinder shall be cast from concrete from a different member in the lot.

909.07.15.04 Sampling of Steel Reinforcement

The Contractor shall retain samples of steel reinforcement according to OPSS 905 for the duration of the Contract and deliver them to the Owner when requested. Samples shall be delivered by the Contractor to:

Head, Concrete Section
Ontario Ministry of Transportation
Room 15, Building C
1201 Wilson Avenue
Downsview, Ontario M3M 1J8

909.07.16 Access for Quality Assurance

The Contractor shall supply electrical power, scaffolding, protection from the weather, and unhindered access to Owner's representatives for inspection and testing of all fabrication, delivery, and erection of prestressed concrete precast members.

For the purposes of cover meter and dimensional measurements, the Contractor shall clear all debris and obstructions and provide the Owner's representative with access.

909.07.17 Delivery

The Contractor shall notify the Contract Administrator in writing, 3 Days prior to delivery of the members.

Delivery shall include transportation and storage of the members. Transportation and storage shall be according to CAN/CSA A23.4. The work shall consist of loading of the members, delivery, unloading, and storage at the storage site and shall include temporary works for access.

Members shall be loaded for shipping in such a manner that they can be transported and unloaded at their destination without being damaged or exposed to stresses for which they were not designed.

Members shall be handled and transported with their webs in a vertical plane, and the points of support during lifting, storing, and transporting shall be according to the Working Drawings.

Members, when stored shall be stored in such a manner to avoid excessive stress or other damage.

Advertising by means of removable signing is permitted on elements only while in transit to the storage site. Any permanent markings on a surface that would be visible after erection shall not be permitted.

909.07.18 Erection

The Contractor shall notify the Contract Administrator in writing of the erection date at least 3 Days prior to the commencement of field erection operations. Erection shall be according to CAN/CSA A23.4.

The work shall consist of erection and stabilization of the members during construction. Members shall be lifted and placed in a manner to ensure they are not overstressed, unstable, or unsafe at any time.

The Contractor shall keep a copy of the Working Drawings on the site and accessible to the Contract Administrator during erection of the members.

The erection tolerance of members shall be ± 15 mm on the bearing in both the longitudinal and transverse directions.

For box members placed side-by-side, accumulated tolerance differences shall be distributed equally along the width of the structure. The maximum accumulated increase or decrease in total width of the members shall not exceed 70 mm with 35 mm maximum on either side.

The forces resulting from the lifting devices acting on the members shall not be inclined to the vertical at an angle greater than 30 degrees. All lifting devices for members shall be removed prior to the deck being poured.

CPCI girders and other members that may experience stability problems during construction shall be braced individually by attaching each end to the respective substructure element, immediately upon erection.

909.07.19 Repair of Defects and Deficiencies Repairable by Standard Methods

The Contractor shall repair any individual member having one or more of the defects and deficiencies identified in Table 2, according to the repair method specified. Such repairs do not require proposals or owner approval. Where more than one of the defects or deficiencies listed in Table 2 are located in the same area in the member, the contractor needs to submit a repair proposal. All causes, preventative actions, and corrective actions, including repair methods and materials used shall be documented.

909.07.19.01 Assessment of Repair

When defects or deficiencies occur, at the discretion of the design Engineer, a visual inspection may be conducted or other measures required, such as cores to be taken to assess the effectiveness of the repairs.

The filling of core holes shall be according to OPSS 1350.

909.07.20 Certificate of Conformance

Within 5 Business Days of erecting all the members within a stage, the Contractor shall submit to the Contract Administrator a Certificate of Conformance sealed and signed by a Quality Verification Engineer. The Certificate shall identify the members and state that the Work has been carried out in general conformance with the signed and sealed documents, which include the Working Drawings, supporting documents, and Contract Documents.

909.07.21 Management of Excess Material

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

909.08 QUALITY ASSURANCE

909.08.01 General

The acceptance of members shall be according to the requirements of this specification, including satisfactory completion of all repairs, if applicable. Members not meeting the requirements of the Contract Documents shall be deemed unacceptable and shall not be included in the Work.

909.08.02 Acceptance of Concrete Compressive Strength

A 28-Day concrete compressive strength of a lot shall be considered acceptable when it meets all of the following:

- a) The average of the three individual compressive strength tests shall be equal to or greater than the specified strength.
- b) No individual cylinder test shall be more than 4.0 MPa below the specified strength.

Unacceptable lots shall be removed and replaced.

Compressive strength shall be determined according LS-426 for concrete with silica fume and high strength concrete and according to LS-407 for all other concrete.

The compressive strength result of the lot shall be the average of the set of three acceptance cylinders rounded to one decimal place.

The individual test results shall be forwarded to the Contractor as they become available.

909.08.02.01 Referee Testing Compressive Strength

If the Contractor has submitted a set of referee cylinders, an individual test result may be questioned by the Contractor within 5 Business Days of receiving the test result. The Contractor shall notify the Owner of his intention to referee test.

The lot shall be re-evaluated as based on the test result from the referee compressive strength cylinders representing the lot and the referee test result shall replace the original test result. The referee test result shall be binding.

909.08.03 Acceptance of Air Void System in Hardened Concrete

One half of a cylinder shall be tested to determine the acceptability of the lot. The cylinder shall be tested according to LS-432. The other half of the cylinder shall be retained by the Owner for audit purposes.

Individual test results shall be forwarded to the Contractor, as they become available.

For a lot to be considered acceptable, the cylinder shall have an air content of 3.0% or more and a spacing factor of 0.200 mm or less. Acceptable lots shall be subject to full payment.

Lots with a spacing factor between 0.200 mm and 0.250 mm shall be repaired as identified in Table 2.

Lots with a spacing factor exceeding 0.250 mm shall be rejected and replaced at the Contractor's expense.

909.08.03.01 Referee Testing of Air Void System in Hardened Concrete

Referee testing of air void system parameters shall be according to OPSS 1350.

909.08.04 Acceptance of Rapid Chloride Permeability

Rapid chloride permeability testing shall be according to LS-433. Acceptance of rapid chloride permeability shall be based on the result obtained on the cylinders representing the lot. Lots with rapid chloride permeability less than 2,500 coulombs are considered acceptable. Lots with a rapid chloride permeability result greater than 2,500 coulombs and less than or equal to 3,500 coulombs shall be considered unacceptable and shall be repaired as identified in Table 2. Lots with rapid chloride permeability results exceeding 3,500 coulombs shall be rejected and replaced.

For concrete lots containing silica fume, rapid chloride permeability less than 1,000 coulombs are considered acceptable. Lots containing silica fume with a rapid chloride permeability result greater than 1,000 coulombs and less than or equal to 2,000 coulombs shall be considered unacceptable and shall be repaired as identified in Table 2. Lots containing silica fume with rapid chloride permeability results exceeding 2,000 coulombs shall be rejected and replaced.

909.08.04.01 Referee Testing of Rapid Chloride Permeability

Referee testing of rapid chloride permeability testing for all concrete shall be carried out according to the high performance concrete requirements of the OPSS 1350 Acceptance of Rapid Chloride Permeability for Silica Fume Overlays and High Performance Concrete clause. The reference to cores in OPSS 1350 shall be interpreted to mean cylinders.

909.08.04.02 Referee Testing Cost of Rapid Chloride Permeability

The cost of rapid chloride permeability testing for all concrete shall be according to OPSS 1350 Acceptance of Rapid Chloride Permeability for Silica Fume Overlays and High Performance Concrete clause.

909.08.05 Dimensional Verification and Concrete Cover Measurements

The Contract Administrator shall carry out measurements to confirm compliance with tolerance requirements of Table 1. Members exceeding the tolerances specified in Table 1 shall be rejected and not incorporated into the Work.

909.08.06 Defects and Deficiencies

909.08.06.01 General

Defects and deficiencies are classified as follows:

- a) Defects and deficiencies repairable by standard methods.
- b) Defects and deficiencies causing rejection.
- c) All other defects and deficiencies.

909.08.06.02**Defects and Deficiencies Repairable by Standard Methods**

Any individual member having one or more of the defects and deficiencies listed in Table 2 shall be deemed unacceptable and the member shall be repaired according to Table 2. When more than one of the defects or deficiencies listed in Table 2 is located in the same area in the member, the Contractor shall be required to submit a proposal for repair for acceptance according to the All Other Defects and Deficiencies clause.

909.08.06.03**Defects and Deficiencies Causing Rejection**

A member having any one of the following defects and deficiencies shall be rejected and shall not be incorporated into the Work:

- a) If concrete temperature exceeds 70 °C at any time during the curing period.
- b) For I-girders, if there is honeycombing, voids, cavities, spalls, delaminations, or cracks, in the concrete within a bearing surface area defined by the contact area of the bearing plus 30 mm on all sides, except when member ends are encased in concrete.
- c) For box girders, if there is honeycombing, voids, cavities, spalls or delaminations in the concrete within a bearing surface area defined by the contact area of the bearing plus 30 mm on all sides, except when member ends are encased in concrete.
- d) If there is a crack in the bottom flange that extends through to the opposite face.
- e) If breakage of strand wires exceeds the limit permitted in CAN/CSA A23.4.
- f) If the sweep of the girder on site and in position without any intermediate bracing is in excess of 1.5 mm/m length of girder.

909.08.06.04**All Other Defects and Deficiencies**

For members with defects or deficiencies that are not identified as rejectable or included in the list of defects and deficiencies repairable by standards methods in Table 2, or when more than one of the defects or deficiencies listed in Table 2 are located in the same area in the member, the Contractor shall submit a proposal for repair to the Contract Administrator for acceptance.

If the repair proposal is deemed acceptable, the members shall be repaired according to the proposal. The Contractor shall not carry out any repairs without the acceptance of the proposal. If the repair proposal is deemed unacceptable, the members shall be rejected and shall not be incorporated into the Work.

The repair proposal, signed and sealed by an Engineer, shall include as a minimum:

- a) Description of the member and identification of the defects or deficiencies.
- b) Detailed sketches, width, length, depths, location, and nature and frequency of any defects.
- c) Assessment of any impact of the repaired defects on durability, structural adequacy, and integrity of the member or on the structure.
- d) A detailed repair plan including material, method, and equipment to be used.
- e) Verification that the repair plan complies with the applicable standards for the type of work.

- f) All relevant supporting information, including material test results, field measurements and observations, production records, photographs, and structural analysis calculations used for determining that the performance and function originally expected from the member shall be met.
- g) Causes of the defect and corrective action to be taken to prevent recurrence of the defect in future production, delivery, or erection.

909.10 BASIS OF PAYMENT

909.10.01 Prestressed Concrete Members (Type) Fabrication - Item Prestressed Concrete Members Containing Silica Fume (Type) Fabrication - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Members stored at the precaster's premises or at some other location away from the Working Area shall be paid for when the Contractor obtains a lease from the property owner that names the Owner as the tenant. The Owner shall provide the form of lease for this purpose that specifies a payment of \$10.00 for the term of the lease. The Contractor shall retain full responsibility for the members.

909.10.02 Payment Adjustment for Rapid Chloride Permeability

For concrete members containing silica fume, lots of members with an average value of rapid chloride permeability exceeding 1,500 Coulombs and less than or equal to 2,000 Coulombs shall be accepted with a payment reduction in addition to the repair method required in Table 2. The payment reduction shall be calculated and applied as follows:

- a) The price for the fabrication items in the Contract shall be converted to an equivalent price per meter length for each member type in the lot.
- b) P_r , the percent payment reduction factor for each lot = 10%
- c) For each member type in the lot, the payment reduction = $(P_r) \times (\text{Equivalent price per meter length}) \times (\text{Length of Members})$.
- d) Total payment reduction for each lot is the sum of the individual payment reductions for each member type calculated in 'c)'.

909.10.03 Prestressed Concrete Members (Type) Delivery - Item Prestressed Concrete Members Containing Silica Fume (Type) Delivery - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

909.10.04 Prestressed Concrete Members (Type) Erection - Item Prestressed Concrete Members Containing Silica Fume (Type) Erection - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

TABLE 1
Tolerances

Item	Tolerances
Length: Straight-line measurement taken horizontally at the mid-height of member	± 1.0 mm/m; not to exceed ± 25 mm maximum
Overall Depth	± 8 mm for depths up to 600 mm ± 12 mm for depths over 600 mm
Flange Depth and Web Width for Members Without Voids	Flange depth ± 5 mm Web width $-5/+10$ mm
Flange Depth and Web Width for Members With Voids	Flange depth ± 10 mm Web width ± 10 mm
Width: Flanges and Box Members	± 10 mm
Sweep: I-girders, spaced box girders and spaced hollow slab girders	1 mm/m length of girder.
Abutting box and hollow slab girders	± 10 mm
Squareness and Plumbness	1 in 200 maximum
Camber Difference: Between adjacent members spaced apart Between adjacent members placed side-by-side	25 mm 15 mm
Hold-Down Position Along Length	± 300 mm
Void and Diaphragm Position Along Length	± 25 mm
Concrete Cover Over Reinforcing Steel	Unless otherwise specified in the Contract Documents, the tolerance for concrete cover over reinforcing steel shall be $-5/+15$ mm
Stirrup Projection	$-10/+15$ mm

TABLE 2
Defects and Deficiencies Repairable by Standard Methods

Repairable Defects and Deficiencies	Condition	Repair Method
Honeycombing, Voids, Cavities, Spalls, and Delaminations	Any area less than an equivalent area of 300 x 300 mm with no reinforcing steel or strand exposed.	a) Square all sides of the repair area. b) Sawcut perimeter of removal area to a depth of 10 mm or to the depth of reinforcing steel or strands, whichever is less. c) Remove all loose concrete using a chipping hammer or hand tools. d) Insert corrosion resistant wire mesh and anchors. e) Abrasive blast-clean all concrete surfaces to be patched according to OPSS 929. f) Remove all dust and loose material from the prepared surface by using compressed air. g) Moisten area to be repaired. h) Fill repair area with concrete or a proprietary patching material. i) Cure concrete according to moist curing requirements of this specification. Cure proprietary patching material according to the manufacturer's recommendations.
Low Cover	Any cover readings less than 25 mm and greater than or equal to 20 mm	The entire surface of the member shall be sealed, except areas against which new concrete is to be placed or in contact with bearings.
Compressive Strength	Any lot with 28-Day compressive strength lower than specified, but not more than 4.0 MPa lower than specified.	The entire surface of the member shall be sealed, except areas against which new concrete is to be placed or in contact with bearings
Rapid Chloride Permeability	Any lot of concrete containing silica fume with rapid chloride permeability value exceeding 1,000 and less than or equal to 2,000 Coulombs and lots of all other concrete with rapid chloride permeability value exceeding 2,500 and less than or equal to 3,500 Coulombs.	The entire surface of the member shall be sealed, except areas against which new concrete is to be placed or in contact with bearings
Air Void System Parameters	Any lot with spacing factor greater than 0.200 mm, but less than or equal to 0.250mm.	The entire surface of the member shall be sealed, except areas against which new concrete is to be placed or in contact with bearings
Sweep	Sweep greater than 1.0 mm /m length but less than or equal to 1.5 mm/m length.	Push or pull the girders to within tolerance. Girders that can be brought into tolerance and maintained at that position without visible signs of distress shall be accepted. Girders greater than or equal to 1,900 mm in depth shall be pulled or pushed at both the top and bottom flange.

Appendix 909-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

Several revisions have been made to the technical information of OPSS 909. It is recommended that the designer and the users read the specification in its entirety to become familiar with the differences and necessary requirements for municipal use.

The designer should specify the following in the Contract Documents:

- Concrete compressive strength. (909.05.03)
- Concrete strength at transfer. (909.07.12, 909.07.14.03)

Subsection 909.07.15, Sampling for Quality Assurance, requires concrete cylinders taken to determine compressive strength, air void system parameters, and rapid chloride permeability to be delivered to the ministry's quality assurance laboratory and samples of steel reinforcement to be delivered to the MTO Concrete Section. For municipal contracts, the designer should write a special provision to delete the delivery locations for samples currently in this specification, and identify the appropriate quality assurance laboratory locations for sample delivery.

Clause 909.07.15.02 requires the use of MTO form PH-CC-322 for reporting concrete test information. If a form other than MTO form PH-CC-322 is to be used for submission purposes, the alternate form should be invoked by reference in the Contract Documents and a special provision should be written to delete the MTO form from the specification.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR STRESSING SYSTEMS FOR POST-TENSIONING

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910.01 SCOPE

This specification covers the requirements for post-tensioning and grouting of prestressed concrete.

910.01.01 Specification Significance and Use

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

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

910.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

910.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 905 Steel Reinforcement for Concrete

Ontario Provincial Standard Specifications, Material

OPSS 1302 Water
OPSS 1304 Packaged Silica Fume Dry Grout Mixture for Post Tensioning
OPSS 1440 Steel Reinforcement for Concrete

Ontario Ministry of Transportation Publications

Structural Manual:
Division 1 - Exceptions to the Canadian Highway Bridge Design Code

Canadian Standards Association

A23.2-1B Viscosity, Bleeding, Expansion, and Compressive Strength of Flowable Grout
[Part of CSA A23.1-04/A23.2-04, Concrete Materials and Methods of Concrete
Construction/Methods of Test and Standard Practices for Concrete]
A283-00 (2003) Qualification Code for Concrete Testing Laboratories
S6-00 Canadian Highway Bridge Design Code

ASTM International

A 53/A 53M-04a	Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
A 416/A 416M-02	Steel Strand, Uncoated Seven-Wire for Prestressed Concrete
D 2239-03	Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter
D 3350-04	Polyethylene Plastics Pipe and Fittings Materials
D 4285-83 (1999)	Indicating Oil or Water in Compressed Air

International Organization for Standardization/International Electrotechnical Commission

ISO/IEC DIS Guide 17025

910.03 DEFINITIONS

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

Calibration means the process of determining experimentally the absolute values corresponding to the gradation on a scale.

Cementing Materials means as defined in OPSS 1304.

Coupler means a device for the joining of two post-tensioning tendons or prestressing bars by means of a mechanical connector.

Deviator means a length of steel pipe placed in deviation blocks or deviation diaphragms to provide a means of changing direction of external tendons.

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

Grout means an initially fluid mixture of cementing materials, aluminum powder, water, and approved admixtures.

Post-Tensioning means a method of prestressing in which tendons are tensioned after the concrete has reached a predetermined strength.

Primary Tendon Anchorages means the anchorage on longitudinal tendons.

Proposal means a Contractor's submission of changes, when engineering design is required, affecting the original design.

Splice-Prestressing Tendon means a connection of one prestressing tendon to another by means of a mechanical connector.

Sublot means the six cubes prepared at one grout material sampling used to determine the 28-Day compressive strength.

Tendon means a high strength steel element consisting of one or more wires, strands, or bars and used to impart prestress to the concrete.

Tensile Strength means the breaking load of the tendon per unit area established by tensile testing.

Vent means an inlet to permit injecting grout into the duct or an outlet to provide for the escape of air and grout, and to bleed or drain water.

Yield Strength means the stress at which the tendon exhibits a specified deviation of proportionality of stress and strain.

910.04 SUBMISSION AND DESIGN REQUIREMENTS

910.04.01 Submission Requirements

910.04.01.01 General

All Working Drawings, stressing details, and calculations shall bear the seal and signature of an Engineer.

When other authorities are involved in the approval of the design or construction of a highway structure, the submission shall be made at least 5 weeks prior to commencement of work and one additional copy of the required submission shall be provided for each authority.

Work shall not commence until written notice to proceed has been given by the Contract Administrator.

At least five weeks prior to commencement of the work, five copies of any proposal shall be submitted to the Contract Administrator.

910.04.01.02 Post-Tensioning Working Drawings

At least three weeks before commencement of the placing of post-tensioning materials, five sets of all Working Drawings shall be submitted to the Contract Administrator. These drawings shall include the following information:

- a) Design details
- b) Slip
- c) Calculation data
- d) Sequence of stressing
- e) Details of the
 - i. Ducts
 - ii. Supports
 - iii. Vents
 - iv. Anchorages

Details of anchorages for post-tensioning tendons shall be according to the supplier's requirements.

All proposed post-tensioning systems shall meet the induced slip requirements specified in the Contract Documents.

Where post-tensioning tendons are anchored internally in concrete, anchorage shall be by means of bulbs crimped onto the ends of individual strands. When anchorages of this type are used, the Working Drawings shall also include the following information:

- f) Anchorage bulb dimensions
- g) Spacing of bulbs
- h) Length of strand embedded in concrete

- i) Ultimate load capacity of the anchorage

910.04.01.03 Stressing Details

At least two weeks prior to the commencement of stressing operations, three copies of the following information shall be submitted to the Contract Administrator:

- a) The elongation calculations that take into account losses due to friction, elastic shortening, relaxation, shrinkage, and creep of concrete where these are applicable and all other causes.
- b) The type of jack.
- c) Friction of jack.
- d) Jacking pressure.
- e) Method of attaining the required slip.
- f) Two copies of the prestressing steel manufacturer's stress-strain curves test reports.

910.04.01.04 Couplers

At least three weeks prior to commencement of the work, a copy of the manufacturer's catalogue giving complete data on the coupler material, installation procedures, and test reports from the manufacturer certifying strength and fatigue requirements shall be submitted to the Contract Administrator.

910.04.01.05 Prestressing Steel Test Certificates

Mill test certificates and stress strain curve test reports shall be according to OPSS 1440.

One copy of mill test certificates for all material to be used in the fabrication of the prestressing steel shall be available for review at the fabricating plant during fabrication. The mill test certificates shall show that the material is according to the Contract Documents.

Where mill test certificates originate from a mill outside Canada or the United States of America, the Contractor shall have the information on the mill test certificate verified by testing by a Canadian laboratory. This laboratory shall be certified by an organization accredited by the Standards Council of Canada to comply with the requirements of ISO/IEC 17025 for the specific tests or type of tests required by the material standard specified on the mill test certificate. The mill test certificates shall be stamped with the name of the Canadian laboratory and appropriate wording stating that the material is in conformance with the specified Contract requirements. The stamp shall include the appropriate material specification number, testing date, and signature of an authorized officer of the Canadian laboratory.

Two copies of the mill test certificates shall be submitted to the Contract Administrator when the material is shipped from the fabrication plant.

910.04.01.06 Certificate of Compliance

The Certificate of Compliance as prepared according to OPSS 1304 that is supplied with the packaged dry grout mixture shall be submitted to the Contract Administrator prior to commencement of grouting.

910.04.01.07 Return of Submissions

Two copies of each submission to be returned shall be marked as one of the following:

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

In this case, work can commence on receipt of the drawing by the Contractor. A copy of these drawings shall be available at the site prior to and during construction.

b) Stamped with the wording that allows for permission to construct as noted.

In this case, work can start on receipt of the drawings by the Contractor. The drawings shall be updated as noted and shall have a stamp affixed that is signed by an Engineer stating the drawings have been revised according to the noted comments. A copy of the stamped updated drawings shall be available at the site prior to and during construction.

c) Showing only required changes.

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

910.04.02 Design Requirements

Design shall be according to CSA S6 and the Structural Manual, Division 1.

910.05 MATERIALS

910.05.01 Ducts

910.05.01.01 General

Sheaths for internal post-tensioning ducts shall be formed from bright steel, galvanized steel, or plastic. The sheaths, including joints, shall be watertight under an internal pressure of 350 kPa shall have corrugations and be non-reactive with concrete, tendons, or grout.

Sheaths for external post-tensioning shall be made from smooth, rigid polyethylene.

All sheaths shall be provided with suitable devices for the injection and discharge of grout after prestressing. Air vents shall be provided at all high points on the tendon sheaths that are continuous over more than one span. Air and drainage vents shall be provided at other locations as specified in the Contract Documents.

Sheaths shall be capable of withstanding concrete pressures without excessive deformation or permitting the entrance of cement paste during the placing of concrete. The ducts shall have sufficient rigidity to maintain the required profile between points of supports.

For single strand or bar tendons, the inside diameter of the sheaths for post-tensioning ducts shall be at least 6 mm larger than the nominal diameter of the strand or bar. For multiple strand tendons, the inside cross-sectional area of the sheath shall be at least twice the cross-sectional area of the prestressing tendon.

The diameter of a duct or an equivalent diameter of a non-circular duct shall not exceed 40% of the least gross concrete section thickness at the duct.

910.05.01.02 Steel Sheaths

Rigid steel sheaths shall have a wall thickness of at least 0.60 mm and shall be capable of being formed to an inside radius of 9 m without distress. Semi-rigid steel sheaths shall have a wall thickness of at least 0.25 mm and shall be capable of being formed to an inside radius of 3.50 m without distress.

910.05.01.03 Plastic Sheaths

Plastic sheaths, including their splices, shall be made of high-density polyethylene according to ASTM D 3350, Cell Classification 324420C, and shall be vapour-tight and remain so after tendon installation and stressing.

Plastic for the external post tensioning sheaths shall be treated to resist deterioration from ultraviolet light according to ASTM D 3350 and coded D or E.

The plastic sheath shall be manufactured according to ASTM D 2239.

Plastic sheaths shall not be used when the radius of curvature of the tendon is less than 10 m. The sheaths shall be capable of bending to the specified minimum radius of curvature without damage. The sheath wall thickness shall be such that for the specified minimum radius of curvature, the remaining wall thickness after a tendon movement of 750 mm under a tendon stress of 80% of the specified strength shall not be less than 1 mm. For curved sheaths, the radial force as exerted by a single strand on the sheath wall shall not exceed 40 kN/m.

The plastic sheaths shall be according to the following:

- a) For sheaths with an inside diameter of 50 mm or less, a 3 m length supported at the ends shall not deflect under its own weight by more than 75 mm at a temperature of not less than 20°C.
- b) For sheaths with an inside diameter of more than 50 mm, a 6 m length supported at the ends shall not deflect under its own weight by more than 75 mm at a temperature of not less than 20°C.
- c) The sheath shall not deform more than 3 mm under a point load of 445 N applied through a No. 10 reinforcing bar located between the corrugation ribs at a temperature of not less than 20°C.

Sheaths and their splices for external post-tensioning shall be smooth, seamless, and capable of withstanding a grouting pressure of at least 1,000 kPa.

- d) Material thickness shall be as follows:

- i. Corrugated, internal duct $1.25 \text{ mm} \pm 0.25 \text{ mm}$.
- ii. External duct shall have an external diameter to wall thickness ratio of 21 or less.

910.05.01.04 Sheaths at Deviators

The sheaths within a deviator for post-tensioning tendons shall be galvanized steel pipe according to ASTM A 53/A 53M, Type E, Grade B, with a wall thickness of not less than 3 mm. The sheath shall be formed to conform to the tendon alignment.

910.05.01.05 Duct Vents

Vents shall be a 20 mm minimum diameter flexible tubing material capable of withstanding the grouting pressures applied to them.

910.05.02 Prestressing Steel

Prestressing steel shall be low alloy steel bar or uncoated, low relaxation 7-wire strand according to OPSS 1440.

910.05.03 Anchorages and Couplers

910.05.03.01 General

When tested in an unbonded condition, anchorages and couplers for post-tensioning shall develop at least 95% of the ultimate strength of the tendons, without exceeding the anticipated set. After tensioning and seating, anchorages shall be capable of sustaining the applied loads without slippage, distortion, or other changes that could result in loss of prestress.

910.05.03.02 Anchorages

The dimensions and details of anchorages, including any reinforcement required to resist tensile, bursting, and anchorage bearing stresses within the local zone, shall be based on the strength of the tendon and the strength of the concrete at transfer as specified in the Contract Documents.

Primary tendon anchorages shall be provided with steel end caps which cover the strand ends and wedges. The steel cap shall have 3 mm minimum wall thickness, and shall have attachments and gaskets that will allow the cap to withstand full grouting pressures. End caps should be vented to ensure complete filling with grout.

Anchorage for unbonded tendons shall not cause a reduction in the total elongation under ultimate load of the tendon to less than 2% measured in a minimum gauge length of 3 metres.

910.05.03.03 Couplers

Couplers shall be according to the submitted manufacturer's data that is approved by the Contract Administrator.

When specified in the Contract Documents, all coupling components for low alloy steel bar shall be protected by a coating material.

910.05.03.04 Testing

A dynamic test for unbonded tendons, shall be performed on a representative anchorage and coupler specimen and the results submitted to the Contract Administrator. The tendon shall withstand, without failure, 500,000 cycles from 60 to 66% of its minimum specified ultimate strength and also 50 cycles from 40 to 80% of its minimum specified ultimate strength. The period of each cycle involves the change from the lower stress level to the upper stress level and back to the lower. The specimen used for the second dynamic test need not be the same used for the first dynamic test. Systems using multiple strands, wires, or bars may be tested using a test tendon of smaller capacity than the full-sized tendon. The test tendon shall duplicate the behavior of the full-sized tendon and generally shall not have less than 10% of the capacity of the full-sized tendon. Dynamic tests are not required on bonded tendons, unless the anchorage is located or used in such manner that repeated load applications can be expected on the anchorage.

910.05.04 Associated Hardware

Only hardware, including spacers and support devices for the sheaths, that is capable of withstanding the loads placed on it, and that is approved by the Owner shall be used. All embedded hardware within 50 mm of exposed faces shall be coated with an acceptable material or be of an acceptable non-metallic material.

910.05.05 Steel Reinforcement

Steel reinforcement shall be according to OPSS 1440.

910.05.06 Dry Grout Mixture

The silica fume dry grout mixture shall be a packaged, commercially available grout, according to OPSS 1304. The packaged dry grout mixture shall be stored in a dry condition up to the time of its use and shall be used within one month of packaging.

910.05.07 Water

Water shall be according to OPSS 1302.

910.05.08 Grout

The grout shall have the following physical properties:

- a) A-28-Day compressive strength of not less than 60 MPa.
- b) Shall not bleed or segregate when allowed to stand for 1 hour.
- c) An expansion of $6\% \pm 2\%$ of its original volume when measured at 1 hour.
- d) The time measurement for the viscosity of the grout shall be between 11 and 25 seconds when the measurements are performed immediately after the grout is removed from the mixer and when measured 30 minutes after mixing.

The grout used for the first set of viscosity measurements shall be discarded after testing and shall not be used for the 30-minute measurement. The grout used for the 30-minute measurement shall be left undisturbed in a clean container covered with a lid until the measurement is performed.

910.06 EQUIPMENT

910.06.01 Air Compressor

The air compressor for air blasting shall have a minimum capacity of $3.5 \text{ m}^3/\text{min}$. The compressed air shall be free of water and oil according to ASTM D 4285.

910.06.02 Stressing Equipment

Pressure gauges, dynamometers, tension meters, load cells, or other suitable devices shall be used for controlling and measuring the tendon forces and shall be according to the following:

- a) Capable of measuring the forces to an accuracy of $\pm 2\%$.
- b) Each gauge shall be capable of indicating forces directly in Newtons or be accompanied by a chart by which the reading can be converted into such units of force.
- c) The indicating dials of gauges shall be at least 150 mm in diameter.
- d) Friction losses in jacks, hoses, and connections shall be determined and recorded.
- e) Each gauge shall be accompanied by a certified calibration curve that bears the seal and signature of an Engineer.
- f) The gauges shall have been calibrated within the six-month period immediately preceding the commencement of the work.

- g) The forces to be measured shall be within 25 and 75% of the maximum graduated capacity of the gauge unless calibration data clearly establishes the gauge is accurate over a wider range.
- h) Pressure gauges shall not fluctuate excessively and shall remain steady until the jacking load is released.
- i) Gauges shall be mounted near eye level and within 2 m of the operator and positioned so that readings can be obtained without parallax.
- j) Provision shall be made for accommodating two gauges at each jack and pump combination.

910.06.03 Grouting Equipment

The grouting equipment shall consist of a mixer, separate holding tank, and pump.

The mixer shall be of the mechanical type with a speed of 1200 to 2000 rpm. The mixer shall be equipped with a calibrated measuring device for determining the quantity of mixing water. The device shall measure the total quantity of water used in each batch of the grout to an accuracy of $\pm 2\%$. The device shall be accompanied by a certified calibration curve that bears the seal and signature of an Engineer. The device shall have been calibrated within the six-month period immediately preceding the commencement of work. The mixer shall be equipped with a visible timing device suitable for controlling the mixing time.

The holding tank shall be capable of keeping the mixed grout continuously in motion until it is used. The outlet to the pump shall have a 5 mm screen.

The grout pump shall be capable of grouting to a pressure of at least 1 MPa and shall be equipped with a pressure gauge and a pressure relief valve set to release at a pressure of 1 MPa. The pressure gauge shall be accompanied by a certified calibration curve which bears the seal and signature of an Engineer, shall have an accuracy of $\pm 5\%$ and shall be calibrated at least once a year.

The grouting equipment shall be of sufficient capacity to ensure that the grouting of the longest duct can be completed within 30 minutes after mixing. The velocity of grout in the duct shall be between 6 and 12 m/min. and the pressure shall be compatible with the length and size of the duct.

The grout hoses and their rated pressure capacity shall be compatible with the pump output and the maximum grouting pressure. All connections from the grout pump to the duct shall be airtight so that air cannot be drawn into the duct.

The configuration of the equipment shall be such that the grout can be recirculated to the holding tank if stoppage occurs in the grouting.

Standby equipment such as a water flushing system and compressed air shall be available at the site before the commencement of grouting in case of a breakdown of the equipment during grouting operations. Suitable equipment to grout a number of ducts simultaneously shall be readily available.

910.06.04 Grout Testing Equipment

The following grout testing equipment shall be provided:

- a) Equipment according to CSA A23.2-1B for the viscosity, bleeding, and expansion measurements.
- b) Stainless steel moulds for preparing cubes for compressive strength tests.
- c) Thermometers for measuring air and grout temperature.

910.06.05 Malfunction of Gauges

Gauges shall be replaced immediately when a malfunction is noted.

910.07 CONSTRUCTION

910.07.01 General

910.07.01.01 Prestressing Staff

The work shall be done by staff employed by or licensed by the manufacturer of the stressing system used.

The staff employed to supervise the work of tensioning and grouting shall have a working knowledge of the prestressing system used and shall be capable of evaluating the forces, gauge pressures, elongations, and method by which the prestressing system transfers the forces to the structure. They shall have a minimum of 5 years experience in carrying out this type of work within the last 10 years. The staff shall be present during these operations and during the concreting operations to ensure the post-tensioning components of the work are not adversely affected.

910.07.01.02 Welding

Except as permitted in the following paragraph, welding equipment shall not use the prestressing steel or sheath as an electrical ground. Welding shall not be permitted within 3 m of the prestressing steel.

Welding of the prestressing tendons will only be permitted to facilitate pulling the tendon through the sheath as specified below. Where the ends of strands are welded together to facilitate pulling the tendon through the sheath, the length of the tendon used as an electrical ground or 1 m, whichever is greater, shall be cut off from the welded end prior to stressing. Care shall be exercised at all times to prevent the possibility of heat destroying the tensile properties of the steel.

910.07.01.03 Surface Condition

All material shall be clean and free of oil, dirt, scale, and pitting. A light rust coating on the steel is acceptable.

910.07.02 Prestressing Steel, Sheaths, and Anchorages

910.07.02.01 Installation

Prestressing steel, sheaths, anchorages, couplers, and local reinforcing steel at anchorages shall be placed in the positions shown in the Contract Documents and held in the correct location during the operations of placing and consolidating concrete.

The sheaths shall be secured at intervals not exceeding 1 m and a smooth profile shall be maintained. All joints in sheaths and between the sheath and other hardware shall be protected against the ingress of laitance during concreting and against the entry of any deleterious material before, during, and after concreting.

Sheaths and anchorages shall be placed according to the following tolerances that apply to horizontal and vertical placement:

- a) Longitudinal sheath ± 15 mm.
- b) Transverse sheath ± 10 mm.

- c) Anchorage ± 10 mm.

Couplers in strand or high strength bars are not permitted in the work unless specified in the Contract Documents.

When couplers are specified in the Contract Documents, they shall be installed according to the recommendations of the manufacturer of the prestressing system used.

910.07.02.02 Vents

Vents shall be installed as follows:

- a) At the anchorages of the tendon.
- b) At the high points of the duct.
- c) At the lowest point of a tendon having a small radius such as a vertical loop.
- d) At major changes in the cross-section of the duct such as trumpets of couplers and anchorages.

Vents shall extend at least 500 mm above the highest point on the profile of the duct in which the vent is placed.

Holes in the duct shall be the same as the inside diameter of the vent.

910.07.02.03 Reinforcing Steel

The placing of reinforcing steel as sheath support bars, spirals, tensioning rings, and reinforcing grids at anchorages shall be according to OPSS 905.

910.07.03 Prestressing Steel Post Tensioning

910.07.03.01 General

The Contract Administrator shall be notified when the prestressing steel is available for sampling at least one week in advance of stressing.

Prestressing steel samples selected by the Contract Administrator for testing shall be labelled by the Contractor and contain the following information:

- a) Manufacturers identification number.
- b) Reel number.
- c) Heat number.
- d) Location of sampled area.

910.07.03.02 Provision of Material Samples

Samples of prestressing materials and dry grout mixture shall be submitted to the Contract Administrator as follows:

- a) For strand, 1 sample 1.0 m long from each reel.
- b) For bar, 1 sample 1.0 m long.

- c) For anchorages and couplers, samples will be selected by the Contract Administrator on a random basis.
- d) For dry grout mixture, representative samples of the packaged material shall be submitted to the Contract Administrator when requested.

910.07.03.03 Tensioning

Tensioning shall not commence until the concrete has attained the strength specified in the Contract Documents.

Tensioning shall be carried out as specified in the Contract Documents and as shown on the stamped Working Drawings.

After tensioning, all openings and vents along the ducts shall be temporarily plugged or sealed until the grouting is performed.

910.07.03.04 Measurement of Tensioning and Variation in the Prestress Force

The force in the tendons shall be determined by means of the pressure gauge and shall be continually verified by means of measuring the tendon elongation. The pressure gauge readings and the elongations for the first five tendons of each type stressed shall be recorded at intervals of 25% of the maximum prestress force including the final reading.

The measured elongations of individual tendons at the specified jacking force, based on the gauge pressures, shall be within -3 to +9% of the calculated values.

When the actual elongation is outside the tolerance of -3 to +9%, jacking shall be stopped at that tendon and the Contractor shall prepare and submit a report rationalizing the observed difference.

The variation from specified total prestress force over the complete component cross-section, including broken strands, shall not exceed $\pm 5\%$. The distribution of the variation of this total prestress force across the component cross-section shall be subject to approval by the Contract Administrator.

910.07.03.05 Maximum Tension

In no case shall the low relaxation steel be tensioned above 85% of its tensile strength and in no case shall any steel be tensioned above 94% of its yield strength.

910.07.03.06 Stressing Records

Records of elongation, calibrated jacking pressure readings, and slippage shall be kept at all times and submitted to the Contract Administrator.

910.07.03.07 Cutting of Tendons

Tendons shall not be cut until the stressing records have been reviewed by the Contract Administrator and written permission to grout has been given by the Contract Administrator. Care shall be exercised at all times in the cutting of tendons to avoid the possibility of adversely affecting the prestressing steel.

Unless other methods are approved by the Contract Administrator cutting of the tendons shall be by mechanical means.

910.07.04 Grouting

910.07.04.01 General

The tendons shall not be grouted until concrete has been placed in the anchorage recesses and permission to grout has been given by the Contract Administrator. Where it is not possible to place concrete in the anchorage recesses prior to grouting, the anchorages shall be sealed to resist the pressure during grouting. Once permission to grout has been received in writing from the Contract Administrator, grouting shall be carried out as soon as possible, but in no case shall any prestressing steel be left ungrouted for more than 7 Days after receipt of permission to grout or more than 14 Days after completion of tensioning.

910.07.04.02 Preparation for Grouting

Dry, oil-free compressed air shall be blown through each duct. Each vent shall be tested in turn to ensure the ducts, vents, inlets, and outlets are capable of accepting the injection of grout.

All ducts shall be cleaned and made free of all deleterious material that may impair bonding of the grout to the ducts and tendons by flushing with water and blowing out with dry, oil free compressed air. Steam shall not be used for cleaning.

All grout vents of each duct shall be open when grouting starts. The elevation of the end of the ejection vent at the free end shall be higher than the high point vents along the duct.

910.07.04.03 Grout Mixing

A standard batch size shall be established and the size of the batch to be used shall be reported to the Contract Administrator prior to the commencement of grouting. The standard batch size shall be used throughout the grouting operation.

The mixing procedure for the grout shall be as follows:

- a) The required amount of water shall be added to the mixer by means of the calibrated measuring device attached.
- b) Packaged dry grout mixture shall be added to the mixer.
- c) The grout shall be mixed for a minimum of 1 minute after the dry grout mixture is added and until the grout is mixed thoroughly and uniformly.

The time between the addition of the dry grout mixture and pumping of the grout shall not exceed 15 minutes. Water shall not be added to the grout after initial mixing.

The holding tank shall be kept at least partially full at all times during the pumping operation to prevent air from being drawn into the duct.

910.07.04.04 Temperature of Grout

The temperature of the grout in the holding tank at the time of injection shall not be less than 15°C or more than 30°C and shall be measured hourly.

910.07.04.05 Grouting Procedures

The temperature of the concrete and the duct shall be at least 5°C before grouting commences and shall be maintained above this minimum temperature at all times during the grouting operation and for 72 hours after grouting is complete.

Grouting shall commence as soon as possible after mixing and shall be carried out in one operation without interruption. A continuous, one-way flow of grout shall be maintained. The pumping pressure at the injection vent shall not exceed 1 MPa. The grout shall be pumped from the lowest grout inlet.

The consistency of grout flowing from a vent shall be examined to determine whether or not the grout is the same consistency as that being pumped in at the injection vent. When the grout is of the same consistency, an additional five litres of grout shall be permitted to flow out prior to closing that vent.

As grout of original consistency flows from the vents, the vents shall be successively closed as the filling of the duct progresses. When grout of original consistency flows from the ejection vent at the free end, that vent shall be closed. Pumping shall be resumed and the high point vents along the duct shall be re-opened, one at a time, starting with the vent closest to the injection vent. Vents shall not be resealed until grout of original consistency emerges. The injection tubes shall be sealed off under pressure when the duct is completely filled with grout. A pressure of approximately 500 kPa shall be maintained for at least 1 minute after sealing.

The grout tubes shall be topped up with grout if a subsidence of grout occurs when disconnecting the pump or pressure apparatus so that grout completely fills the ducts and openings. After the grout has hardened, the grout tubes shall be cut off flush with the surface of the deck and any tubes not completely full of grout shall be topped up flush with the surface of the concrete.

After grouting is completed, any residue of grout remaining on concrete surfaces adjacent to the vents shall be removed.

After grouting, loads shall not be applied to or removed from the structure until the grout has reached a compressive strength of at least 20 MPa. For the purposes of this clause, removal of falsework and formwork shall not constitute a load on the structure.

910.07.05 Quality Control

910.07.05.01 General

The 28-Day compressive strength test results of the grout from the manufacturer shall be submitted to the Contract Administrator upon receipt.

In addition to the quality control procedures initiated by the Contractor, the following work shall also be done.

910.07.05.02 Grout Mixture

910.07.05.02.01 General

Viscosity, bleeding, and expansion measurements and preparation of cubes for compressive strength tests shall be done on a level, vibration free surface.

The Contractor shall use staff from a testing laboratory certified by an organization accredited by the Standards Council of Canada according to CSA A283 for Additional Tests according to CSA A23.2-1B. The test cubes shall be prepared by this staff.

Grout mixture showing evidence of dampness, lumps, hardened pieces, or contamination shall not be incorporated in the work.

910.07.05.02.02 Bleeding, Expansion, and Viscosity Tests

Prior to the grouting operation and in the presence of the Contract Administrator, a trial batch shall be mixed and the grout tested according to CSA A23.2-1B for bleeding, expansion, and viscosity to ensure that the grout meets the requirements specified herein before the grouting is to proceed. The trial batch of grout shall not be used in the actual grouting operation.

During the grouting operation, the bleeding, expansion, and viscosity tests shall be performed according to CSA A23.2-1B on the grout sampled at the mixer. The tests shall be performed at least once a day and as requested by the Contract Administrator.

Copies of the bleeding, expansion, and viscosity test shall be submitted to the Contract Administrator. Any test result which indicates the grout is not meeting the requirements specified herein shall be reported immediately to the Contract Administrator and the grouting operation halted until the cause of the problem is identified and corrected. The grout supplier shall also be immediately notified when the grout mixed as specified fails to meet the test requirements for bleeding, expansion, and viscosity.

910.07.05.02.03 Sampling for Compressive Strength Tests

Cubes for compressive strength tests shall be prepared according to CSA A23.2-1B on site from the grout pumped into the ducts, as follows:

- a) The total volume of grout used for grouting one structure represents one lot.
- b) At least four random sublots of grout samplings shall be taken at the mixer for each lot. Six cubes shall be made from each 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 sampling shall be taken once per day and as directed by the Contract Administrator.

The cubes shall be identified as coming from the mixer or the anchorage outlet and shall be stored at a temperature between 15 and 25°C and shall not be moved prior to demoulding. The cubes shall be demoulded within 24 hours $\pm$ 4 hours and the cubes representing the Owner's sample shall be given to the Contract Administrator. The cubes shall be presented in a sealed white opaque plastic bag containing at least 250 ml of water.

910.07.05.02.04 Early Compressive Strength Tests

The Contractor shall prepare and test the grout compressive strength test cubes according to OPSS 1304 to determine when the grout has attained a strength of 20 MPa.

The laboratory conducting the test shall be CSA certified as specified herein.

910.07.06 Prestressing Steel Friction Test

Where the elongations shown on the stamped stressing details of the Working Drawing submission and the actual elongations differ from the clause for Measurement of Tensioning, the Contract Administrator may require the Contractor to conduct a friction test on one or more tendons to check the theoretical value of friction used in the design and elongation calculation.

The results of these tests shall be submitted to the Contract Administrator.

910.07.07 Test Reports

A copy of all test reports shall be submitted to the Contract Administrator.

910.07.08 As Built Drawings

As built drawings shall be prepared by the Contractor as follows:

- a) For all work incorporated into the completed structure that required the submission of Working Drawings.
- b) For all changes from the original Contract Document requirements.

The as built drawings shall be submitted to the Contract Administrator in a reproducible format prior to final acceptance of work.

The as built drawings shall bear the seal and signature of an Engineer.

910.07.09 Management of Excess Material

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

910.08 QUALITY ASSURANCE

910.08.01 Testing of Prestressing Steel

The testing of prestressing steel strand and bars shall be according to ASTM A 416/A 416M

910.08.02 Anchorages, Spirals, and Couplers

Anchorage, spirals, and couplers shall be examined for conformance with the Contract Documents and the manufacturers requirements.

910.08.03 Grout

Using the prepackaged samples submitted to the Contract Administrator, a trial batch may be made according to OPSS 1304 and tested for the specified properties.

The compressive strength test shall be according to CSA A23.2-1B.

Samples of the grout may be taken from the mixer and tested.

The grout shall be examined for acceptability as it flows from the vents and anchorages prior to closure.

910.08.04 Anchorage Outlet Sampling of Grout

The grout samples obtained from the anchorage outlet shall be tested and compared with the 28-Day compressive strength test cubes.

910.08.05 Material, Stressing Records, and Test Results

Post-tensioning material, stressing records, and test results shall be examined for conformance to the Contract Documents.

910.10 BASIS OF PAYMENT

**910.10.01 Longitudinal Stressing System - Item
Transverse Stressing System - Item
Vertical Stressing System - Item**

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Fifty percent of the Contract price shall be paid on completion of the stressing. The remainder shall be paid after completion of the grout curing and review of the 28-Day compressive strength test results by the Contract Administrator and be based on any payment adjustment calculated.

910.10.02 Stressing System Payment Adjustment

The results of the compressive strength tests of the six cubes made for each subplot shall be averaged. The average of the test results for all sublots shall then be averaged. The Contract price for the stressing system will be reduced by 2% for each MPa this average is below 60 MPa.

The calculations will be based on the compressive strength of the cubes made from samples taken at the mixer.

Appendix 910-A, November 2005
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

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

Designer Action/Considerations

The following shall be specified in the Contract Documents:

- Proposed post-tensioning systems, induced slip requirements. (910.04.01.02)
- Other locations for air and drainage vents. (910.05.01.01)
- Strength of tendon and strength of concrete at transfer. (910.05.03.02)
- Coupling components for low alloy steel bar to be protected by a coating material. (910.05.03.03)
- Ultimate strength. (910.05.01.03.04)
- Location of prestressing steel, sheaths, anchorages, couplers, and local reinforcing steel at anchorages. (910.07.02.01)
- Couplers in strand or high strength bars when permitted in the work. (910.07.02.01)
- Concrete strength required for tensioning and tensioning procedures. (910.07.03.03)
- Anchorages, spirals, and couplers. (910.08.02)
- Post-tensioning materials, stressing records, and test results. (910.08.05)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

None



CONSTRUCTION SPECIFICATION FOR COATING STRUCTURAL STEEL SYSTEMS

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

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

911.01.02 Appendices Significance and Use

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

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

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

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

911.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 919 Formwork and Falsework

Ontario Provincial Standard Specifications, Material

OPSS 1704 Paint Coating Systems for Structural Steel

Ontario Ministry of Transportation Publications

Structural Manual

CSA Standards

G164-M92 (R2003)	Hot Dip Galvanizing of Irregularly Shaped Articles
G189-1966 (R2003)	Sprayed Metal Coating for Atmospheric Corrosion Protection
S6-06	Canadian Highway Bridge Design Code

ASTM International

A 780-01 (2006)	Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
C 566-97 (2004)	Test Method for Total Evaporable Moisture Content of Aggregate by Drying
D 4285-83 (2006)	Test Method for Indicating Oil or Water in Compressed Air
D 4417-03	Test Methods for Field Measurement of Surface Profile of Blast Cleaned Steel
D 4541-02	Test Methods for Pull-Off Strength of Coatings Using Portable Adhesion Testers

D 4940-96 (2006)	Test Methods for Conductimetric Analysis of Water Soluble Ionic Contamination of Blasting Abrasives
D 6386-99 (2005)	Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting

The Society for Protective Coatings (SSPC)

Good Painting Practice, SSPC Painting Manual Vol.1, 4th Edition, 2002
 AB 1, September 2000 - Mineral and Slag Abrasives
 PA 1, April 2000 - Shop, Field, and Maintenance Painting of Steel
 PA 2, May 2004 - Measurement of Dry Coating Thickness with Magnetic Gauges
 SP 1, September 2000 - Solvent Cleaning
 SP 8, September 2000 - Pickling
 SP 11, November 2004 - 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, September 2000	White Metal Blast Cleaning
SP 6/NACE No. 3, September 2000	Commercial Blast Cleaning
SP 10/NACE No. 2, September 2000	Near-White Blast Cleaning

Others

Federal Standard 595C Colors, 2008 - Published by U. S. General Services Administration
 Environmental Protection Act, Ontario Regulation 347, General - Waste Management - R.R.O. 1990

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.

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

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, the Contractor shall submit 5 sets of each of the following submissions 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 spent material.

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, the Contractor shall retain two Engineers 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. The Contractor shall retain documentation of such evaluation 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 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 Contractor shall supply the Contract Administrator 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 Contractor shall supply the Contract Administrator 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.

911.04.02.06 Documentation for Management of Spent Material

911.04.02.06.01 Test Results

Where abrasive blast cleaning of existing structural steel and railing system is required, test results from testing for management of spent material shall be provided to the Contract Administrator a minimum of 2 Days prior to shipment of the material tested.

For each sample tested, original documentation shall be provided by the selected Canadian Association for Environmental Analytical Laboratories (CAEAL) accredited laboratory indicating the following:

- a) Laboratory name and address and identification of the individual responsible for accuracy of test results.
- b) Sample identification, including contract number and date sampled (i.e., yyyy,mm,dd).
- c) Laboratory report of analysis containing the analytical results.
- d) A certificate specifying the analysis performed, methodology used for analysis of each parameter, and instrumentation.
- e) A quality control certificate indicating:
 - i. The test results.
 - ii. The upper and lower limits for process per cent recovery and matrix spike recovery.
 - iii. A statement indicating that each test result is acceptable relative to the upper and lower limits.

A record of all test sample numbers and sample dates shall be kept and made available to the Contract Administrator upon request.

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 coating systems for coating galvanized surfaces 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 Colours, unless otherwise specified.

911.05.02 Metal Coatings

911.05.02.01 Hot Dip Galvanizing

Hot dip galvanizing shall be according to CAN/CSA G164M.

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 from the MTO's pre-qualified products list or, when specified in the Contract Documents, the Owner's pre-qualified products list. The colour of the finish coat shall be equivalent to 17178 aluminum according to Federal Standard 595C Colours.
- 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 from the MTO's pre-qualified products list or, where specified in the Contract Documents, the Owner's pre-qualified products list,

911.05.02.02 Thermal Sprayed Metal Coatings

Thermal sprayed metal coatings shall be according to CSA G189. The metallizing wire shall be an alloy consisting of 85% zinc and 15% aluminum.

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 microsiemens, 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 Contractor shall allow access by the Contract Administrator 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 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.

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

Sharp edges of 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.

New structural steel 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 specified to be cleaned and 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 CAN/CSA G164M.

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 paint coatings and rust shall be removed by abrasive blast cleaning according to SSPC-SP 6/NACE No.3 and then the components shall be cleaned to the requirements of SSPC-SP 8 prior to being galvanized.

Sharp edges including the edges of bolt holes of components specified to be paint coated after hot dip galvanizing shall be ground to a smooth radius of at least 3 mm by hand or power tools, prior to pickling.

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.

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.

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 given a prime coat and finish coat by brush in addition to the spray application. When inorganic zinc primer is specified, the brush application shall be carried out with an epoxy-zinc primer from the same manufacturer after the spray application of the prime coat. The finish coat shall be brush applied prior to 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

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.

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 structural steel including diaphragms, excluding surfaces in contact with concrete and the faying surfaces of bolted joints, shall be coated to the extent specified in the Contract Documents. Faying surfaces of bolted joints shall have only the prime coat applied.

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. If the prepared galvanized steel component is exposed outdoors, 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 according to 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 as shown in Table 1.

An epoxy-zinc, epoxy, polyurethane coating system shall consist of three coats with dry film thickness as shown in Table 2.

An inorganic-zinc, water-based acrylic, water-based acrylic coating system shall consist of three coats with dry film thickness as shown in Table 3.

An inorganic-zinc, epoxy, polyurethane coating system shall consist of three coats with dry film thickness as shown in Table 4.

A coal tar epoxy coating system shall consist of two coats with dry film thickness as shown in Table 5.

High build epoxy, aliphatic polyurethane coating system for coating galvanized surfaces shall consist of two coats with dry film thickness as shown in Table 6.

Modified aluminum epoxy mastic, aliphatic polyurethane coating system for coating galvanized surfaces shall consist of two coats with dry film thickness as shown in Table 6.

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 conforming 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.

Hot dip galvanizing shall be according to CAN/CSA G164-M.

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.

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. Support at spacing not greater than 6 metres shall also be provided during cooling after galvanizing.

The Contractor shall submit two copies of the galvanizer's coating thickness readings 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 CSA G189 to provide a minimum coating thickness of 200 µm. Thermal sprayed metal coating shall have a minimum bond strength of 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 as specified in 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.

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 50 µm.

911.07.04.03.04 Repair of Hot Dip Galvanizing

The Contractor shall notify the Contract Administrator, 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 structure re-dipped in a galvanizing bath according to CAN/CSA G164M.

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 CSA G189 to provide a minimum thickness of 200 µm, applied in two separate coats.

The metal coating on the repaired areas shall have a minimum adhesion of 2.8 MPa when tested according to ASTM 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 in the MTO's pre-qualified products list or when specified in the Contract Documents, the Owner's pre-qualified products list shall be used for repair of galvanized coating defects on overhead trusses.

Only the epoxy zinc primer listed in the MTO's pre-qualified products list or when specified in the Contract Documents the Owner's pre-qualified products list, 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 Contractor shall notify the Contract Administrator, 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 CSA G189 to provide a minimum thickness of 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 cured, dried, or set paint coating materials on steel or aluminium panels from each individual paint coat from each batch of paint coatings used in coating operations are required for testing.

The details of samples required are as follows:

- a) Cured primer only samples on 2 clean steel or aluminium panels from each batch.
- b) Cured mid coat only samples on 2 clean steel or aluminium panels from each batch.
- c) Cured topcoat only samples on 2 clean steel or aluminium panels from each batch.

In addition to the cured, dried, or set samples of paint coating materials, at Contract Administrator's discretion, the Contractor shall sample 250 ml liquid samples of each component of the paint coating materials of the system used.

The above samples shall be prepared in the field and delivered by the Contractor to:

Head, Concrete Section
Ontario Ministry of Transportation
Room 15, Building C
1201 Wilson Avenue
Downsview, Ontario M3M 1J8

Samples of steel or aluminium panels and 250 ml metallic sample containers for liquid paint coatings shall be supplied by the Contractor to the Contract Administrator.

Clean bare steel or aluminium panels measuring not less than 305 mm long by 152 mm wide and having a minimum thickness of 0.8 mm shall be used as the coating substrate. The coating material shall be applied to the entire panel surface at a minimum thickness of 75 µm. The coated panel shall be removed from the work area and allowed to dry, cure, and set on a flat surface. Information from the coating manufacturer's product data sheets shall be used to ensure proper curing of the material. The coated panels shall be protected from possible contamination from the time of preparation to shipping.

The manufacturer's name, product code, batch number, contract number, and the name of the structure on which the coating is being applied shall be clearly identified at the back of the panel before submitting the coated sample panels to the Contract Administrator.

911.07.05.02 Metallic Coating Materials

When the application of thermal sprayed metal coating is specified in the Contract Documents, the Contractor shall submit a 1.0 m long metallizing wire from the same batch used in the work 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

The Contractor shall execute ongoing quality control of the cleaning and coating application operations, including measurements of temperature, humidity, dew point, surface profile, and coating thickness. 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 Contractor shall demonstrate the existence of negative pressure within the enclosure by instrument measurements or by visual assessment 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.

The magnetic gauge shall be calibrated according to the procedures in SSPC-PA 2. To facilitate the calibration procedure, the Contractor shall mask off a 75 x 75 mm area of the prepared steel at a location selected by the Contract Administrator. 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 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 Spent Materials**

Management of spent material shall include sampling, testing, documenting, transporting, and disposing of spent material and may include re-use or recycling according to the Contract Documents.

Spent material that is tested to be leachate toxic (i.e., waste class 146 T) shall be managed as subject waste according to the Contract Documents.

Spent material that is tested to be non-leachate toxic (i.e., non-hazardous solid) shall be managed by disposal as non-hazardous solid industrial waste or by re-use or recycling according to the Contract Documents.

911.07.09.01**Sampling and Testing**

Prior to transportation from the work site, samples of spent material shall be collected and submitted to an analytical laboratory for analysis.

Samples taken to determine waste classification shall be representative of the spent material to be managed, such that they accurately characterize the variation that may exist throughout the waste pile or container (e.g., vertically and horizontally). This may be achieved by collecting multiple samples using a grain sampler, auger, or other similar sampling equipment or technique.

One 500 gram representative composite sample of spent material shall be prepared for the first 12 m³ or less of material. An additional sample is required for every additional 12 cubic metres or less of material.

The Contractor shall notify the Contract Administrator a minimum of 24 hours prior to collecting each sample of spent material.

Samples shall be prepared as follows:

- a) Prior to each sampling, the sampling equipment shall be thoroughly cleaned with a detergent solution; rinsed with clean water, preferably distilled water; and allowed to air dry.
- b) For every 12 m³ or less of spent material, a minimum of one 500 gram sub-sample shall be collected from each container (e.g., drums and barrels) of waste that represents the specified volume to be tested. For larger size containers (e.g., lugger bins) a minimum of two 500 gram sub-samples shall be collected (i.e., one from the centre and one from either end).
- c) A composite sample of the specified volume of material to be tested shall be prepared by combining individual sub-samples into a clean plastic or steel bucket.
- d) The combined sample shall be thoroughly mixed.
- e) The sample shall be piled into a cone while placing it on a clean plastic sheet. As the material is emptied from the bucket, it shall be placed at the cone's apex and allowed to run down the sides of the cone.

- f) The cone shall be flattened into a rough circle of uniform thickness. The circle shall be divided into four quarters and two opposite sides shall be rejected.
- g) The procedure of coning and quartering (i.e., steps e) and f)) shall be repeated to obtain a single composite 500 gram sample for analysis.
- h) Each composite sample shall be divided into two halves and placed into laboratory cleaned jars or zip sealed plastic bags and labelled with the following information:
 - i. Sample ID (i.e., spent material from abrasive blasting of structural steel)
 - ii. Sample number.
 - iii. Date sampled (i.e., yyyy-mm-dd).
 - iv. Name of sampler.
 - v. Name of Contractor.
 - vi. Work project number.

One half of each sample shall be submitted to the analytical laboratory, and the other half shall be retained by the Contract Administrator in a secure location.

The samples shall be tested according to the Toxicity Characteristic Leaching Procedure under Ontario Regulation 347 to determine the concentration of arsenic, barium, boron, cadmium, chromium, lead, mercury, selenium, silver, and any other parameter specified by Ontario Regulation 347 that may be associated with any previous use of the blasting medium.

Management of spent material shall be based on the laboratory test results and shall be subject to the approval of the Contract Administrator.

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 by Type 2 constant pressure probe magnetic gauges according to SSPC-PA 2.

Determination of the acceptability of the dry film thickness of each coat shall be made according to SSPC-PA 2.

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 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 of 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.

911.10 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.

Payment at the contract price for the tender items Coating Existing Structural Steel and Coating Steel Railing System shall include full compensation for all labour, Equipment, and Materials for the management of spent material, except waste class 146T.

Any costs for the disposal of spent material as waste class 146T, that are additional to those for disposal as a non-hazardous solid industrial waste, shall be paid as Extra Work provisions of the Contract.

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
Clean up 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
Coal Tar Epoxy Coating System

Coat	Dry Film Minimum Thickness µm
Prime	200
Second	200

TABLE 6
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

The designer should specify the following in the Contract Documents:

- Type of paint coating system to be applied. (911.05.01)
- Type of seal coating system to be applied. (911.05.01.01)
- Galvanized surfaces to be paint coated. (911.05.01.02)
- Extent of work (i.e., surfaces (new and existing) to be cleaned, prepared, and coated). (911.07.01)
- Difficult access areas. (911.07.03.07)
- Laboratory requirements. (911.07.05.01)

The designer should determine if the following is required and, if so, specify it in the Contract Documents:

- A tender item for environmental protection requirements. (911.04.02.03.01, 911.10.01)
- Owner's pre-qualified products list for coating system for repair of metal coating on sign support structures and sectional high mast lighting poles. (911.05.02.01, 911.07.04.03.04 c))

OPSS 911 contains information that is not used by municipalities in their Contracts. To ensure completeness of the municipal Contract Documents, the designer should invoke Appendix 904-B. The appendix contains information that modifies OPSS 911 so it can be used by a municipality on its Contracts.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

Appendix 911-B, November 2014

FOR USE IN MUNICIPAL CONTRACTS, WHEN REFERENCED IN THE CONTRACT DOCUMENTS

Note: This is a non-mandatory Additional Information Appendix intended to provide supplementary requirements for the OPS specification in a municipal contract, when the appendix is invoked by the Owner. It is written in mandatory language to permit invoking it by reference in the Contract Documents. If the appendix has not been invoked by reference in the Contract Documents, it does not apply.

Supplemental Requirements for Using OPSS 911 in Municipal Contracts

OPSS 911, Coating Structural Steel Systems, is amended as follows:

911.07.05.01 Paint Coating Materials

The sixth and seventh paragraph of clause 911.07.05.01 (i.e., from “The above samples” to “M3M 1J8”) are deleted in their entirety and replaced with the following:

The above samples shall be prepared in the field and delivered by the Contractor to the laboratory specified in the Contract Documents.



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

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

914.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

914.02 REFERENCES

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

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

Ontario Provincial Standards Specifications, Material

OPSS 1212	Hot-Poured Rubberized Asphalt Joint Sealing Compound
OPSS 1213	Hot Applied Rubberized Asphalt Waterproofing Membrane
OPSS 1215	Protection Board

Ontario Ministry of Transportation Publications

MTO Field Guide, for the Acceptance of Hot Mix and Bridge Deck Waterproofing

Canadian General Standards Board (CGSB)

37-GP-9MA (1983)	Primer, Asphalt, Unfilled for Asphalt Roofing, Dampproofing and Waterproofing

ASTM International

D 4285-83 (2006)	Test Method for Indicating Oil or Water in Compressed Air

914.03 DEFINITIONS

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

Deck means the upper concrete surface of a structure to which waterproofing membrane shall be applied.

Lot means a single bridge deck or part of a bridge deck with a surface area of 800 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 split longitudinally for staged construction shall be treated as separate decks. The Contract Administrator shall determine the exact limits of each lot.

Mean means the arithmetic average of the test results for waterproofing membrane thickness within the lot.

Protection Board means a durable panel specifically designed to provide an interface protection barrier between the asphalt and the waterproofing membrane.

Random Location means a location determined by the Contract Administrator based on random numbers or, if protection boards are used, it means the exposed corner of a protection board closest to that location.

Standard Deviation means the square root of the value found by summing the squares of the difference between each test result and the mean of the test results divided by the number of test results minus one.

Sublot means the area within which membrane thickness is measured. There are 10 sublots within a lot calculated as length of lot ÷ 10 x lot width.

914.05 MATERIALS

914.05.01 Waterproofing Membrane

The waterproofing membrane shall be hot applied rubberized asphalt according to OPSS 1213 and shall be supplied to the job site in cakes in the manufacturer's sealed and labelled containers ready for melting and application.

914.05.02 Waterproofing Membrane Reinforcement

Waterproofing membrane reinforcement shall be spun bonded sheet structure composed of 100% continuous filament polyester fibres bonded together at their crossover points and shall be acceptable to the Owner. The membrane shall be supplied in minimum widths of 450 mm. The material shall be unaffected by the heat generated by the waterproofing membrane and the hot mix.

914.05.03 Hot-Poured Rubberized Asphalt Joint Sealing Compound

The hot-poured rubberized asphalt joint sealing compound shall be according to OPSS 1212.

914.05.04 Protection Board

Protection board shall be according to OPSS 1215.

914.05.05 Tack Coat

The tack coat used in conjunction with the waterproofing membrane shall be primer cut back with an equal volume of gasoline type solvent or an acceptable alternative cut-back asphalt product. The primer shall be according to CAN/CGSB-37-GP-9MA.

914.06 EQUIPMENT

914.06.01 Heating and Mixing Kettle for Waterproofing Membrane and Hot-Poured Rubberized Asphalt Joint Sealing Compound

Approved heating and mixing kettles shall be used for the waterproofing membrane and the hot-poured rubberized asphalt joint sealing compound.

The kettles shall be of the double boiler oil heat transfer type with a built-in agitator and equipped with 2 functional permanently installed dial type thermometers with an accuracy of ± 2 °C to measure the temperature of the melted compound and the oil.

914.06.02 Thermometer

A separate calibrated thermometer with an accuracy of ± 2 °C to verify the material temperature shall be available on the job site.

914.06.03 Air Compressor

The compressor shall provide oil and water free compressed air. The compressed air shall be tested according to ASTM D 4285.

914.07 CONSTRUCTION

914.07.01 General

914.07.01.01 Bridge Deck Waterproofing

Bridge deck waterproofing shall consist of:

- a) Deck surface preparation.
- b) Application of the tack coat.
- c) Application of the waterproofing membrane.
- d) Application of the protection board used with the waterproofing membrane.
- e) Repair of unacceptable or borderline lots due to waterproofing membrane thickness deficiency.
- f) Handling and controlling of traffic.
- g) Application of the waterproofing membrane reinforcement.
- h) Forming and filling of grooves where there are no separate tender items for this work.

914.07.01.02 Traffic Restrictions

After abrasive blast cleaning operations have commenced, traffic shall not be allowed on the abrasive blast cleaned area until after the hot mix binder course has been placed and cooled to ambient temperature.

The traffic restrictions apply to all traffic other than the construction equipment directly associated with the waterproofing operations and the paving operations that follow.

914.07.01.03 Procedure

Waterproofing operations shall only be carried out when the air and concrete surface temperature are 5 °C or higher. The waterproofing operations shall be performed sequentially with no delay between operations other than delays that may be required by this specification.

Drainage holes through the deck shall not be plugged or covered by either waterproofing membrane or protection boards.

914.07.01.04 Notice of Commencement of Waterproofing Operations

At least 48 hours prior to the commencement of any waterproofing operations, the Contract Administrator shall be informed, in writing, of the date and time the Contractor intends to commence the work.

Waterproofing shall not commence until permission is given by the Contract Administrator.

914.07.01.05 Existing Asphalt Covered Decks

When an asphalt riding surface is to be stripped from the existing concrete structure deck, at least 7 Days prior to the commencement of the asphalt stripping operation, the Contract Administrator shall be informed, in writing, of the date and time the Contractor intends to commence the work.

914.07.01.06 Applicators

A firm certified to apply the waterproofing membrane by the manufacturer of the product shall carry out the application of the waterproofing membrane.

914.07.02 Deck Surface Preparation

914.07.02.01 Treatment of Grout Tubes on Deck Surfaces

The grout tubes shall be cut flush with the deck surface prior to sand blasting and shall be recut flush with the concrete surface if sandblasting results in the tube projecting from above the concrete. A 450 x 450 mm piece of membrane reinforcement, centred on the tube, shall be installed as specified herein.

914.07.02.02 New Concrete Bridge Decks and Concrete Deck Overlays

The surface of the concrete shall be completely treated by abrasive blast cleaning or other such methods as the Contract Administrator may approve to expose sound laitance-free concrete. Curing compound used on the concrete surface shall be completely removed. All dirt and debris shall be removed from the bridge deck. Immediately prior to the application of the tack coat, the concrete surface shall be cleaned with a jet of oil-free compressed air to remove all dust and other foreign material.

914.07.02.03 Existing Deck Surface Preparation

All areas of the concrete deck that have a textured surface, not including sawcut grooves, shall be bush hammered, ground down, or scabbled to reduce the depth of texture to 2 mm or less prior to the abrasive blast cleaning operation for waterproofing.

Prior to waterproofing, all concrete surfaces shall be treated in accordance with the New Concrete Bridge Decks and Concrete Deck Overlays clause.

914.07.02.04 Modification of Deck Joint Assemblies of Existing Bridge Decks

Modifications to the expansion joint assemblies involving welding or other means of attachment to existing armouring shall be carried out prior to waterproofing.

914.07.02.05 Modification of Deck Drains

Modification of deck drains shall be as specified in the Contract documents. The modifications shall be made prior to waterproofing the deck.

914.07.03 Tack Coating

A tack coat shall be applied wherever waterproofing membrane is to be applied. The tack coat shall terminate in the chase or, where there is no chase, be extended up the face of the curbs, barrier walls, expansion joints, and deck drains to the level of the top of the proposed hot mix base course. The tack coat material shall be uniformly applied at the rate of 0.25 l/m^2 using equipment approved by the manufacturer of the tack coat material. The tack coat shall be applied when the concrete is surface dry and clean. Waterproofing equipment shall not be permitted upon the tack coat until it has fully cured.

Drying of the concrete surface shall not be expedited by use of a torch or any other means.

914.07.04 Application of Waterproofing Membrane

Cakes of asphalt waterproofing membrane shall be melted on the job site and shall be continuously agitated in the mechanically agitated heating and mixing kettle. The contents shall be continuously agitated until the material can be drawn free flowing and lump free from the mixing kettle at a temperature within the range recommended by the manufacturer.

Areas of the deck with sawcut grooves shall be filled with a scratch coat of waterproofing after the tack coat has cured. The waterproofing membrane shall be applied immediately after application of the scratch coat.

Waterproofing membrane shall not be applied until the tack coat has cured completely. The tack coat shall also be free of any surface moisture and dirt and it shall not be dried by torch or any other means. The waterproofing membrane shall be applied within the temperature range recommended by the manufacturer to form a uniform film having a thickness of $5 \pm 1 \text{ mm}$. 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 such that the joints lap in the direction of traffic flow and be staggered a minimum of 150 mm.

Binder course pavement shall be placed within 7 Days of waterproofing.

914.07.07**Form and Fill Grooves**

Where hot mix asphaltic concrete is carried directly over expansion and fixed joints and where specified in the Contract Documents, a 20 mm wide and 20 mm deep rectangular groove shall be formed.

This groove shall be made either by dry sawing or routing with vertical sides and be located directly over the joint for the full length of the joint.

Immediately prior to placing the hot-poured asphaltic sealing compound, the groove shall be dry and clean of any dust or debris using oil-free compressed air.

Cakes of joint sealing compound shall be melted on the job site and shall be continuously agitated in the mechanically agitated heating and mixing kettle. The contents shall be continuously agitated until the material can be drawn free flowing and lump free from the mixing kettle at a temperature within the range recommended by the manufacturer.

Joint sealing compound shall be poured using hand pouring pots, mechanical methods, or any other method that gives satisfactory results.

Shields shall be provided to prevent the compound from being spilled on the concrete curb, barrier or parapet walls, expansion joints, deck drains, and on the newly placed hot mix asphalt.

Sufficient joint sealing compound shall be poured into the groove so that upon completion of the work the surface of the compound is flush with the surface of the pavement. If the compound subsides to a level below the surface of the pavement, a second pouring shall be done. When more than one pouring is required to fill the groove, succeeding pours shall be made immediately.

Damage to the joint sealing compound, such as stones embedded in the compound or that is caused by the Contractor's operation, shall be repaired.

Traffic shall not be permitted over the joint sealing compound until the compound has cooled to ambient temperature.

914.07.08**Samples for Testing****914.07.08.01****Delivery of Samples**

Samples of the waterproofing membrane, waterproofing membrane reinforcement, joint sealing compound, tack coat, and the protection board shall be delivered by the Contractor to:

Head, Concrete Section
Ontario Ministry of Transportation
Room 15, Building C
1201 Wilson Avenue
Downsview, Ontario, M3M 1J8

914.07.08.02**Membrane Quality**

A 4 litre sample from each lot of waterproofing membrane shall be drawn by the Contractor from the heating and mixing kettle and placed in a container supplied by the Contract Administrator. The samples shall be delivered as specified in the Delivery of Samples clause.

The Contract Administrator shall determine the time of sampling as specified in the Field Guide for the Acceptance of Hot Mix and Bridge Deck Waterproofing.

914.07.09 Management of Excess Material

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

914.08 QUALITY ASSURANCE

914.08.01 Testing of Samples Other than Waterproofing Membrane

The samples of the waterproofing membrane reinforcement, joint sealing compound, tack coat, and protection board delivered by the Contractor to the Owner shall be tested for conformance with the requirements in this specification.

914.08.02 Acceptance of Waterproofing Membrane Thickness

914.08.02.01 General

The Contract Administrator shall determine the acceptability of the waterproofing membrane thickness by determining the waterproofing membrane thickness on a lot-by-lot basis.

914.08.02.02 Testing of Membrane Thickness

The Contract Administrator shall obtain a test result from each subplot. Each test result shall consist of 3 measurements taken at the corners of an imaginary triangle centered about the random location. The sides of the imaginary triangle shall be approximately 0.1 m. The 3 measurements shall be averaged, rounded to the closest 1 mm, and reported as one test result. Measurements shall be made according to the Field Guide for the Acceptance of Hot Mix and Bridge Deck Waterproofing and shall be taken after the Contractor has completed each lot, including the placement of protection board.

914.08.02.03 Membrane Thickness Acceptance Determination

The decision to accept the waterproofing membrane thickness shall be based on the mean and standard deviation of each lot, as specified in this clause.

a) Case 1 - Lot mean is less than 4.0 mm

If the lot mean is less than 4.0 mm, the entire lot is unacceptable. In such cases the Contractor shall repair the entire lot as outlined below.

b) Case 2 - Lot mean is greater than or equal to 4.0 mm and less than or equal to 6.0 mm

If the lot mean is greater than or equal to 4.0 mm and less than or equal to 6.0 mm, the mean and the standard deviation shall be rounded to the closest 0.1 mm and 0.05 mm, respectively, and shall then be applied to Table 1 to determine if the lot is in the acceptable, borderline, or unacceptable range.

If the lot is within the borderline range as shown in Table 1, the Contractor may repair the lot as outlined below or request that the Owner accept the lot as is with a payment adjustment as outlined in the Payment Adjustment Due to Membrane Thickness Deficiency clause.

If the lot is within the unacceptable range as shown in Table 1, the Contractor shall repair the lot as specified below.

c) Case 3 - Lot mean is greater than 6.0 mm

If the lot mean is greater than 6.0 mm, regardless of the standard deviation, the Contract Administrator shall review the conditions to which the bridge deck shall be exposed and then designate the deck as acceptable or unacceptable. When the lot is designated unacceptable, the Contractor shall repair the lot as outlined below.

914.08.02.04 Repair of Unacceptable or Borderline Lots

When the Contract Administrator identifies an unacceptable lot or the Contractor chooses to improve a borderline lot, the repairs deemed necessary by the Contractor to upgrade the lot shall be made. Any protection boards that are removed during the repairs shall be replaced with new ones. The Contract Administrator shall determine a new set of random locations and shall re-measure and re-evaluate the entire lot for acceptance when notified that the repairs have been completed.

914.08.02.05 Retesting of Waterproofing Membrane Thickness

The Contractor may request retesting if any or all of the 10 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.

914.08.03 Acceptance of Waterproofing Membrane Quality

914.08.03.01 General

The Contract Administrator shall determine the acceptability of the waterproofing by determining the membrane quality on a lot-by-lot basis.

914.08.03.02 Sampling and Testing of Membrane Quality

The sample delivered by the Contractor to the Owner shall be split into two approximately equal parts: one part shall be tested immediately and the other shall be retained for possible retesting. If the tested part fails any of the specification requirements, the retained part shall be kept for 40 Days after the Contractor has been notified of the test results. If the Contractor requests retesting within this time period, the retained part shall be used for this purpose, otherwise it shall be discarded.

914.08.03.03 Membrane Quality Acceptance Determination

The decision to accept the quality of the hot applied waterproofing membrane shall be based on the results of tests performed according to OPSS 1213 and the following criteria.

Membrane quality shall be considered:

- a) Acceptable, if all specification requirements for the lot are met; or
- b) Borderline and subject to payment adjustment as outlined in the Payment Adjustment Due to Membrane Quality Deficiency clause, if the total number of adjustment points resulting as shown in Table 2 are less than or equal to 25; or
- c) Rejectable, if the total number of adjustment points are greater than 25 or if any individual test result falls within the unacceptable range.

914.08.03.04 Retesting for Quality

The Contractor may request, in writing, retesting of any sample, which results in price adjustment or rejection of a lot; however, the request shall be made within 30 Days of receiving notification of price adjustment or rejection of the lot. The results of the retest shall be used for acceptance determination and shall be binding on both parties. If the retest results in either a price adjustment or rejection of the lot, the Contractor shall bear the cost of the retesting. If the retesting results in the material passing all test criteria, a retesting charge shall not be levied against the Contractor.

914.09 MEASUREMENT FOR PAYMENT

914.09.01 Actual Measurement

914.09.01.01 Bridge Deck Waterproofing

Measurement of bridge deck waterproofing shall be by area in square metres. Allowance shall not be made in the measurement for the turn-up at vertical faces, for any overlap, or for a second application of waterproofing membrane over the membrane reinforcement. Alternatively, bridge deck waterproofing may be a lump sum item.

914.09.01.02 Membrane Reinforcement

Measurement of membrane reinforcement shall be by length in metres. Allowance shall not be made in the measurement for the turn-up at vertical faces or for any overlap.

914.09.01.03 Form and Fill Grooves

Measurement of forming and filling grooves shall be by length in metres.

914.09.01.04 Modification of Deck Drains

For measurement purposes, a count shall be made of the number of deck drains modified, regardless of type and size.

914.09.01.05 Deck Surface Preparation

Measurement of deck surface preparation shall be by area in square metres.

914.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

914.10 BASIS OF PAYMENT

914.10.01 Bridge Deck Waterproofing - Item Membrane Reinforcement - Item Form and Fill Grooves - Item Deck Surface Preparation - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

When the Contract does not contain separate tender items for the work required by this specification, payment at the Contract price for the tender item Bridge Deck Waterproofing shall be full compensation for all labour, Equipment, and Material to do the work.

When repairs or remedial work to the concrete deck is required prior to abrasive blast cleaning and the work is not specified in the Contract Documents, payment for the cost of such work shall be administered as Extra Work.

Repairs to damaged grooves shall be made at the Contractor's expense at no additional cost to the Owner.

914.10.01.01 Payment Adjustment Due to Membrane Thickness Deficiency

When a lot is within the acceptable range as shown in Table 1, a payment adjustment factor of 1.00 shall be applied to the Contract price for the lot.

When a lot is within the borderline range as shown in Table 1 and the Contractor requests that the Owner accept the lot as is, the Contract price for the item Bridge Deck Waterproofing shall be multiplied by the payment adjustment factor specified in Table 1 to determine the adjusted Contract price for the lot.

914.10.01.02 Payment Adjustment Due to Membrane Quality Deficiency

Quality Payment Adjustment Factors are calculated as follows:

- a) If the sample meets all test criteria as shown in Table 2, the Contract Administrator shall assign a quality adjustment factor of 1.00.
- b) If the sample fails one or more test criteria, the adjustment points as shown in Table 2 for each failed criteria shall be totalled. The Contract Administrator shall assign a quality adjustment factor which shall be 100 minus the total of all the adjustment points and the results divided by 100.
- c) If the sample fails one or more test criteria, the adjustment points as shown in Table 2 for each failed criteria shall be totalled and if the total number of points exceed 25, the Owner shall not pay the Contractor for the lot regardless of the adjustment factor for thickness.
- d) If an individual test result is inside the rejection value range, the Owner shall not pay the Contractor for the lot, regardless of the adjustment factor for thickness.

914.10.01.03 Calculation for Total Adjustment Payment

The total adjusted payment for the lot shall be based on the thickness and on the quality for the waterproofing membrane and is calculated as follows:

The Contract price for the lot shall be multiplied by the thickness adjustment factor and the results shall then be multiplied by the quality adjustment factor.

914.10.02 Modification of Deck Drains - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

TABLE 1
Acceptance Determination and Payment Adjustment Factors Membrane Thickness

		Lot 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	Una	.86	.95	.99	Acc									.65	
	.70	Una	.59	.87	.96	.99	Acc								.70	
	.75		Una	.71	.89	.96	.99	Acc							.75	
	.80			Una	.76	.91	.96	.99	Acc						.80	
	.85				Una	.81	.91	.96	.99	Acc					.85	
	.90					Una	.83	.92	.97	.99	.99	Acc			.90	
	.95					Una	.64	.84	.93	.97	.99	.99	Acc		.95	
	1.00						Una	.71	.87	.93	.97	.99	.99	Acc	1.00	

Table 1 continued on next page.

TABLE 1 (Cont'd)
Acceptance Determination and Payment Adjustment Factors Membrane Thickness

		Lot 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	Una	.76	.87	.94	.97	.99	.99	Acc								1.05	Lot Standard Deviation	
	1.10		Una	.79	.89	.94	.97	.99	.99	Acc							1.10		
	1.15		Una	.59	.81	.90	.95	.97	.99	.99	Acc						1.15		
	1.20			Una	.64	.83	.91	.95	.97	.99	.99	Acc					1.20		
	1.25				Una	.71	.84	.91	.95	.97	.99	.99	Acc				1.25		
	1.30					Una	.76	.86	.92	.95	.97	.99	.99	Acc			1.30		
	1.35						Una	.77	.87	.92	.95	.98	.99	.99	Acc		1.35		
	1.40						Una	.59	.79	.87	.93	.96	.98	.99	.99	Acc	1.40		
	1.45							Una	.68	.82	.88	.93	.96	.98	.99	.99	1.45		
	1.50								Una	.71	.83	.89	.93	.96	.98	.99	1.50		
	1.55									Una	.74	.84	.90	.94	.96	.98	1.55		
	1.60										Una	.78	.86	.91	.94	.96	1.60		
	1.65											Una	.64	.79	.87	.91	.94		1.65
	1.70												Una	.88	.81	.87	.91		1.70
	1.75													Una	.71	.82	.87		1.75
	1.80														Una	.74	.83		1.80
1.85														Una	.59	.76	1.85		
1.90															Una	.64	1.90		
1.95																Una	1.95		
2.00																Una	2.00		

Notes:

- A. Cells containing the Payment Adjustment Factors form the borderline range.
- B. "Acc" means acceptable. All cells above cells containing Payment Adjustment Factors form the acceptable range.
- C. "Una" means unacceptable. All cells below cells containing Payment Adjustment Factors form the unacceptable range.

TABLE 2
Acceptance Determination and Payment Adjustment Factors Membrane Quality

Test	Specification Limits	Adjustment Points	Rejection Value
Cone Penetration at 25 °C	Max. 110	0.4 per 1	> 130
Cone Penetration at 50 °C	Max. 160	0.4 per 1	> 180
Flow at 60 °C	Max. 3 mm	0.5 per 1	> 5
Low Temperature Flexibility at -25 °C	Pass	5.0 for Failure	--
Toughness	Min. 5.5	0.5 per 0.1	< 4.0
Toughness/Peak Load	Min. 0.040	0.5 per 0.001	< 0.030

Appendix 914-A, November 2014
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

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

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Location of any 20 mm wide and 20 mm deep rectangular groove required in the asphaltic concrete. (914.07.07)

OPSS 914 contains information that is not used by municipalities in their Contracts. To ensure completeness of the municipal Contract Documents, the designer should invoke Appendix 914-B. The appendix contains information that modifies OPSS 914 so it can be used by a municipality in its Contracts.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

Appendix 914-B, November 2014

FOR USE IN MUNICIPAL CONTRACTS, WHEN REFERENCED IN THE CONTRACT DOCUMENTS

Note: This is a non-mandatory Additional Information Appendix intended to provide supplementary requirements for the OPS specification in a municipal contract, when the appendix is invoked by the Owner. It is written in mandatory language to permit invoking it by reference in the Contract Documents. If the appendix has not been invoked by reference in the Contract Documents, it does not apply.

Supplemental Requirements for Using OPSS 914 in Municipal Contracts

OPSS 914, Waterproofing Bridge Decks with Hot Applied Asphalt Membrane, is amended as follows:

914.07.08.01 Delivery of Samples

Clause 914.07.08.01 is deleted in its entirety and replaced by the following:

Samples of the waterproofing membrane, waterproofing membrane reinforcement, joint sealing compound, tack coat, and the protection board shall be delivered to the Contract Administrator.



CONSTRUCTION SPECIFICATION FOR SIGN SUPPORT STRUCTURES

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915.01 SCOPE

This specification covers the requirements for the design and construction of the tri-chord, cantilever, variable message, monotube overhead, bridge mounted, and roadside breakaway and non-breakaway sign support structures, including their footings.

915.01.01 Specification Significance and Use

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

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

915.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

915.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 501	Compacting
OPSS 603	Installation of Ducts
OPSS 609	Grounding
OPSS 902	Excavating and Backfilling - Structures
OPSS 903	Deep Foundations
OPSS 904	Concrete Structures
OPSS 905	Steel Reinforcement for Concrete
OPSS 906	Structural Steel for Bridges
OPSS 907	Structural Wood Systems
OPSS 911	Coating Structural Steel Systems
OPSS 919	Formwork and Falsework

Ontario Provincial Standard Specifications, Material

OPSS 1010	Aggregates - Base, Subbase, Select Subgrade, and Backfill Material
OPSS 1350	Concrete - Materials and Production
OPSS 1440	Steel Reinforcement for Concrete
OPSS 1601	Wood - Preservative Treatment and Shop Fabrication

Ontario Ministry of Transportation Publications

Sign Support Manual

Structural Manual

CSA Standards

G40.20-04/G40.21-04 (R2009)	General Requirements for Rolled or Welded Structural Quality Steel / Structural Quality Steel
S6-06	Canadian Highway Bridge Design Code
S157-05/S157.1-05 (R2010)	Strength Design in Aluminum / Commentary on CSA S157-05, Strength Design in Aluminum
W47.2-11	Certification of Companies for Fusion Welding of Aluminum
W59-03 (R2008)	Welded Steel Construction (Metal Arc Welding)
W59.2-M1991 (R2008)	Welded Aluminum Construction
W178.1-08	Certification of Welding Inspection Organizations
W178.2-08	Certification of Welding Inspectors

American Association of State Highway and Transportation Officials (AASHTO)

LTS-5-M	Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, 5th Edition, with 2010 Interim Revisions

ASTM International

A 307-10	Carbon Steel Bolts and Studs 60,000 PSI Tensile Strength
A 325-10	Structural Bolts, Steel, Heat Treated 120/105 ksi Minimum Tensile Strength
A 325M-09	Structural Bolts, Steel Heat Treated 830 MPa Minimum Tensile Strength, Metric
A 500-10a/A500M-10a	Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
B 209M-07	Aluminum and Aluminum Alloy Sheet and Plate, Metric
B 221M-07	Aluminum and Aluminum Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
F 593-02 (2008)e1	Stainless Steel Bolts, Hex Cap Screws, and Studs

Canadian General Standards Board (CGSB)

48.9712-2006	Non-Destructive Testing-Qualification and Certification of Personnel

International Organization for Standardization/International Electrotechnical Commission (ISO/IEC)

17025-2005, 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.

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

Column means the vertical member of a roadside sign support structure that has the base section of the member buried below grade and the upper section connected to a sign or sign support.

Crank Location means the joint in the end panel of a variable message sign support structure where the horizontal chords meet the sloping chords.

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

Leg means the vertical member of an overhead sign support structure that connects to the sign support footing.

Overhead Monotube Sign Support Structure means an overhead sign support structure consisting of two vertical single steel tubing legs spanned by a single steel tubing member.

Overhead Sign Support Structure means a structure for supporting signs over a roadway.

Proposal means a Contractor's submission for which engineering design is required that provides a written:

- a) Alternative to requirements specified by the Owner in the Contract Documents.
- b) Course of action or undertaking by the Contractor, as delegated by the Owner in the Contract Documents.

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

Roadside Sign Support Structure means a timber or steel, breakaway or non-breakaway, sign support structure, consisting of two or more columns on the side of the roadway.

Sign means a variable message board or a signboard.

Sign Support Structure means an overhead sign support structure or a roadside sign support structure.

Sweep means the deviation from straightness of a member or any portion of a member with respect to its minor axis.

Tri-Chord Sign Support Structure means a static sign support structure consisting of a galvanized steel overhead truss constructed in the form of a three-chord system and having tubular legs.

Variable Message Sign Support Structure means an overhead sign support structure with two steel legs, consisting of a pair of trussed members, and an aluminum truss spanning the roadway.

915.04 DESIGN AND SUBMISSION REQUIREMENTS

915.04.01 Design Requirements

Sign support structure design shall be according to CAN/CSA S6, AASHTO LTS-5-M, the Sign Support Manual, the Structural Manual, and the requirements of this specification.

The catwalk grating shall be designed for a live load of 5 kPa.

Welding design shall be according to CSA W59.2M for aluminum and CSA W59 for steel.

915.04.02 Submission Requirements

915.04.02.01 General

Working Drawings and erection procedures shall be according to the Contract Documents. An Engineer's seal and signature shall be affixed on the Working Drawings and erection procedures verifying that they are consistent with the requirements of the Contract Documents.

All submissions shall be according to the appropriate clause.

When other authorities are involved in the approval of the design or construction of a highway structure, the submission shall be made at least 5 weeks prior to commencement of work and one additional copy of the required submission shall be provided for each other authority.

915.04.02.02 Working Drawings for Sign Support Structures

The Contractor shall submit 3 sets of Working Drawings to the Contract Administrator at least 7 Days prior to commencement of fabrication of overhead sign support structures, for information purposes only.

The fabricator shall have a sealed and signed copy of the Working Drawings at the manufacturing facility during fabrication. Working Drawings shall include at least the following information:

- a) Fabrication details.
- b) Specifications of the material to be used.
- c) Design, assembly, and detail drawings including welding procedures according to CSA W59.2-M for aluminum and CSA W59 for steel.
- d) Fastener torquing values and methods.
- e) For variable message sign support structures, structural details of the sign, including the catwalk, aluminum skin, and attachment to the sign support structure.
- f) Coating requirements.

915.04.02.03 Delivery Schedule for Overhead Sign Support Structures

The delivery schedule of overhead sign support structures and their components to the galvanizing or painting facility or both, and to the site, shall be provided to the Contract Administrator not less than 7 Days before shipping begins.

915.04.02.04 Rock Excavation

If rock is present within the depth of the footing as specified in the Contract Documents, the Contractor shall submit the proposed method of rock excavation to the Contract Administrator at least 14 Days prior to the commencement of excavation, for information purposes only.

915.04.02.05 Erection Procedures for Overhead Sign Support Structures

The Contractor shall submit 3 copies of the erection procedures to the Contract Administrator at least 7 Days prior to the commencement of overhead sign support structure erection, for information purposes only.

The Contractor shall have a copy of the erection procedures at the site during erection. The erection procedures shall include at least the following:

- a) Proposed method and sequence of erection.
- b) Weight and lifting points of the members.
- c) Locations and lifting capacities of the cranes to be used to lift the members.
- d) Details of temporary bracing and temporary supports used during construction, including time and sequence of removal.
- e) Calculations.
- f) Fastener torquing values and methods.
- g) Method of maintaining the columns and anchorages vertical and in the specified location in the footings until the concrete has set.
- h) Erection tolerance between the end diagonal and the corbel for the tri-chord sign support structure truss.

915.04.02.06 Proposals

The Contractor shall submit 5 copies of any proposal by the Contractor to the Contract Administrator at least 14 Days prior to commencement of the work for review. Proposals shall bear the seals and signatures of a design Engineer and a design-checking Engineer. The Contractor shall not proceed with the changes until the Contract Administrator has accepted the proposal.

915.04.02.07 Mill Test Certificates

Prior to the use of any material in fabrication, 2 copies of the mill test certificates for that material shall be submitted to the Contract Administrator confirming that the material is according to the Contract Documents.

Verification that bolts, nuts, and washers meet the chemical composition, mechanical properties, dimensions, workmanship, and head burst as required by the appropriate ASTM specification specified in the Contract Documents shall also be submitted to the Contract Administrator.

Copies of the mill test certificates for all material to be used in the fabrication shall be available for review at the fabricating plant during fabrication. The certificates shall show that the material is according to the Contract Documents.

If the material cannot be identified by mill test certificates, coupons shall be taken and tested and these test certificates shall be made available.

When mill test certificates originate from a mill outside Canada or the United States of America, the Contractor shall have the information on the mill test certificate verified by testing by a Canadian laboratory. This laboratory shall be certified by an organization accredited by the Standards Council of Canada to comply with the requirements of ISO/IEC 17025 for the specific tests or type of tests required by the material standard specified on the mill test certificate. The mill test certificates shall be stamped with the name of the Canadian laboratory and appropriate wording stating that the material is in conformance with the requirements as specified in the Contract Documents. The stamp shall include the appropriate material specification number, testing date (i.e., yyyy-mm-dd), and the signature of an authorized officer of the Canadian laboratory.

915.04.02.08 Inspection Company and Inspector Information

The Contractor shall submit the names of the inspection company and the inspectors, together with proof of certification, to the Contract Administrator a minimum of 7 Days prior to commencement of fabrication of overhead sign support structures, for information purposes only.

915.05 MATERIALS

915.05.01 General

Material not specified in the Contract Documents shall be appropriate for its end use and shall be compatible with the sign structure metal.

915.05.02 Aluminum

Extruded aluminum tubing shall be 6061-T6 alloy according to ASTM B 221M.

Aluminum sheet and plate shall be 6061-T6 alloy according to ASTM B 209M.

Dissimilar metal shall not come in contact with aluminum.

915.05.03 Fasteners

Stainless steel fasteners shall be according to ASTM F 593, Alloy 304 or 316.

Lock nuts shall be nylon insert type.

Galvanized steel fasteners shall be according to ASTM A 307, ASTM A 325, or ASTM A 325M as specified in the Contract Documents and the requirements of the High Strength Bolts, Nuts, and Washers subsection of OPSS 906.

915.05.04 Clamps

Clamps shall be as specified in the Contract Documents.

915.05.05 Steel

Steel shall be according to CSA G40.21, ASTM A 500, OPSS 906, and as specified in the Contract Documents.

915.05.06 Concrete

Concrete shall have a nominal minimum 28-Day compressive strength as specified in the Contract Documents, and shall be according to OPSS 1350.

A superplasticizer shall be used to attain a slump of 150 mm $\pm$ 30 mm.

915.05.07 Reinforcing Steel

Reinforcing steel shall be a minimum Grade 400W steel and shall be according to OPSS 1440.

915.05.08 Wood

Wood shall be Grade No. 1 Coast Douglas Fir, or Grade No. 1 Jack Pine - Beam and Stringer Grade, or Post and Timber Grade categories as specified in the Contract Documents, and shall be according to OPSS 1601.

Wood shall be pressure preservative treated according to OPSS 1601.

915.05.09 Anchorage Assembly

Bolts, studs, struts, and coils shall be as specified in the Contract Documents. The anchorage assembly shall be hot dip galvanized according to the Contract Documents. The anchorage assembly shall be supplied with the fasteners installed in a rigid template.

915.05.10 Primer and Locking Compound

The thread-locking compound shall be a removable medium strength, single component anaerobic thread locking material that allows disassembly with hand tools. The primer shall be as recommended by the manufacturer of the locking compound.

915.05.11 Electrical

Ducts and fittings for electrical work shall be as specified in the Contract Documents and according to OPSS 603.

Electrical grounding posts at handholes shall be according to OPSS 609.

915.05.12 Granular Backfill

Granular backfill shall be as specified in the Contract Documents and according to OPSS 1010.

915.05.13 Coatings

Paint and metallic coatings shall be as specified in the Contract Documents and according to OPSS 911.

915.07 CONSTRUCTION

915.07.01 Fabrication

915.07.01.01 Aluminum Sign Support Structures

915.07.01.01.01 General

The aluminum fabrication shall be according to CSA W59.2M.

Cutting shall be done by shearing, sawing, milling, or plasma arc. Flame cutting of components is not permitted. In straightening out parts, only plastic or rubber hammers shall be used. All sharp edges and burrs shall be removed. Components cracked or ruptured at any time shall be replaced.

915.07.01.01.02 Welding

The company performing the welding shall be certified according to CSA W47.2, Division 1 or Division 2.1. Qualification for welding and workmanship shall be according to the requirements of CSA W59.2M.

Welding jigs and fixtures shall be used to hold the connector assemblies in position during fabrication.

All areas to be welded shall be free of grease and cleaned with grease free aluminum or stainless steel brushes. All Welds shall be made using MIG process according to CSA S157, Section 26.12. All welds shall be cleaned of soot.

Components to be joined by fillet welding shall have a separation no greater than 1.5 mm.

Unless noted on the Working Drawings or otherwise approved in writing by the Contract Administrator, field welding shall not be permitted. When field welding is permitted, it shall be done by a welder certified for all position welding according to CSA W47.2.

915.07.01.01.03 Bridge Mounted Sign Support Structures

When the location of attachment on a structure is not specified in Contract Documents, the attachment to the structure shall be located to minimize the fatigue affects on the support structure as determined by the Contract Administrator.

For anchors, the Contractor shall prepare, clean, and place adhesive in the drill holes as per the manufacturer's recommendations. Prior to drilling holes, the Contractor shall locate existing steel reinforcement, Utility ducts, post tensioning hardware, and any unsound concrete in the vicinity of the dowel locations. The Contractor's installation operations shall not damage the steel reinforcement, the surrounding concrete, or any other embedments.

915.07.01.02 Steel Sign Support Structures

915.07.01.02.01 General

The steel fabrication shall be according to the Working Drawings and OPSS 906, except as specified in this specification.

Circular structural tubing shall have no more than one longitudinal weld. Octagonal legs shall have no more than two longitudinal welds. Longitudinal welds in legs shall be full penetration and done using an automatic welding process. Longitudinal welds in legs shall be in a plane through the centroid of the section that is parallel to the signboard.

If an octagonal cross section is used for the legs, it shall be produced by mechanically bending the material. The centroid of the octagonal section shall be coincident with the specified circular shape.

915.07.01.02.02 Welding

Welding shall be according to CSA W59. All accessible welds, except fillet welds, shall be ground smooth.

915.07.01.02.03 Steel Monotube Overhead Sign Support Structures

The members shall be octagonal in cross-section and when tapered, the taper shall be uniform. Legs shall have one or two longitudinal automated electrically welded joints along their full length.

Circumferential welds shall be full penetration welds and shall be ground flush on the exterior face. The maximum permitted number of circumferential welded joints in a member length, as measured between the connections shall be as follows:

- a) Up to and including 9 m - one weld.
- b) Greater than 9 m - two welds.

Circumferential welds shall not be located less than 2.7 m from a bolted connection and all welding shall be carried out prior to galvanizing.

Sweep, in millimetres, shall not exceed:

$$(\text{Total Length of Member in Metres} / 15) \times 10.4 \text{ mm}$$

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 shall be hot dip galvanized according to OPSS 911.

The galvanized surface to receive a subsequent paint coating shall be specified in the Contract Documents. Coating of the components shall be according to OPSS 911.

915.07.01.03 Mechanical Access for Electrical Work

Legs adjacent to the power source shall be fabricated with handhole frames complete with covers and gaskets. The strength of the leg at the section through the handhole shall not be less than the original section. When specified in the Contract Documents, grounding lugs, fuse clips, and access nipples for wiring shall be installed during shop fabrication.

915.07.01.04 Identification of Overhead Sign Support Structures

Each sign support structure shall have a site identification marking located approximately 1 m above the footing showing the following information:

- a) Site identification number.
- b) Manufacturer's name or trademark.
- c) Date of manufacture.
- d) Maximum sign area.
- e) Design wind pressure.

The marking shall be on a corrosion resistant plate securely attached by means of stainless steel band clamps. The plate shall be attached on the right leg viewed in the direction of traffic. The maximum size of plate shall be 150 x 150 mm.

The site identification number, maximum sign area, and design wind pressure for each sign support structure shall be as specified in the Contract Documents.

915.07.01.05 Shipment of Sign Support Structures and Their Components

Each sign support structure shall be shipped, complete with hardware, suitably packaged to ensure that all components are delivered together with tags attached noting the site identification number. The fuse connector clip and grounding post shall be assembled inside the leg before shipment.

915.07.01.05.01 Transporting, Unloading, Storing, and Handling Components

The components shall only be handled at the lifting points shown in the Working Drawings using non-metallic lifting slings.

The components that are to receive a paint coating after galvanizing shall be identified when delivered to the galvanizing plant.

The Contractor shall perform all work necessary to ensure safe loading, delivery, unloading, and storage of components at the specified site. Components shall be loaded for shipping in a manner that they can be transported and unloaded at its destination without being overstressed or damaged. When stored, components shall be stockpiled to avoid permanent deformation or damage.

Advertising by means of removable signing is permitted on elements only while in transit to the specified site. Painting of advertisements directly on elements is not permitted.

915.07.01.05.02 Storage of Signboard Chord Clamps

When the Contract Documents do not include the installation of the signboard for each overhead sign structure, the chord clamps required for fastening the sign shall be placed in burlap bags with tags marked with the size of clamps and the identification number of the sign structure on which they are to be used. Chord clamps prepared in this manner shall be delivered to the Owner for storage as specified in the Contract Documents.

915.07.02 Footings for Overhead Sign Support Structures

915.07.02.01 General

The footings shall be constructed plumb to within 1H:100V.

The tolerance for the location of the centre of the constructed footing shall be 75 mm from the location as specified in the Contract Documents.

915.07.02.02 Excavation

The excavation shall be to the lines and grades as specified in the Contract Documents and according to OPSS 902.

Cylindrical shaft footings for overhead sign support structures shall be constructed as caisson piles according to OPSS 903.

When soil with unexpected very low bearing capacity or unexpected rock is encountered at a depth less than the full depth of the footing, the excavation shall be stopped and the Contract Administrator shall be notified immediately.

915.07.02.03 Formwork

Formwork shall be according to OPSS 919.

The footing shall be formed to a minimum of 150 mm below finish grade. Formwork shall be removed to a minimum depth of 150 mm below finished grade prior to placing granular backfill.

915.07.02.04 Reinforcing Steel

Reinforcing steel shall be placed according to OPSS 905.

915.07.02.05 Anchorage Assembly

The anchorage assembly shall be installed level to the tolerances as specified in the Contract Documents. The tolerance for the location of the centre of the anchorage assembly shall be 50 mm from the centre of the footing. Anchorage assemblies shall be securely tied to the reinforcing steel and provided with supports to maintain its position during the placing of concrete. The anchorage assembly shall not be welded to the reinforcing cage and shall remain plumb to within 1H:200V. The anchorage assembly setting templates shall remain in place until after the curing period of the concrete.

The tolerance for the centre to centre of the anchorage assemblies for the following structure types shall be according to the following:

Tri-chord sign support structure:	- 25 mm to + 50 mm
Variable message sign support structure:	± 25 mm
Monotube overhead sign support structure:	± 25 mm

A primer and locking compound shall be applied to the anchor bolts during erection of the overhead sign structure.

Bedding grout shall not be used under the base plates for tri-chord, cantilever, or monotube overhead sign support structures.

915.07.02.06 Electrical Ducts and Fittings

All work for electrical ducts and fittings shall be according to OPSS 603.

When rigid duct sleeves in footings are specified in the Contract Documents, they shall be located to suit incoming duct or cable systems and shall be securely tied to steel reinforcement, prior to placing concrete.

All rigid duct sleeves shall be cut off cleanly above the footing ensuring a minimum projection of 150 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 locations as specified in the Contract Documents using fasteners appropriate for the application.

915.07.07 Quality Control

915.07.07.01 General

The quality control of all fabrication processes shall be according to OPSS 906, except as modified in this specification.

An inspector performing the visual inspection shall be certified according to CSA W178.2. Certification shall be to either Level II or III for the methods used.

A testing company shall be employed by the Contractor to do the non-destructive testing of welds and shall be an independent testing organization that is certified by the Canadian Welding Bureau to the requirements of CSA W178.1 for testing of industrial structures by radiographic, ultrasonic, magnetic particle, and liquid penetrant test methods.

Testing shall be done by a non-destructive testing technician certified by the Canadian Welding Bureau according to CAN/CGSB 48.9712. Certification shall be either Level II or III for the methods used.

The technician and the testing company shall not be changed without the prior approval of the Contract Administrator.

Visual inspection and non-destructive testing of steel components shall be according to CSA W59 and as specified in this specification. The acceptance standards of CSA W59 for dynamically loaded structures shall apply.

Visual inspection and non-destructive testing of aluminum components shall be according to CSA W59.2M and as specified in this specification. The acceptance standards of CSA W59.2M for dynamically loaded structures shall apply.

915.07.07.02 Fabrication, Inspection, and Testing

The materials used shall be identified in the fabricator's plant and shall be certified to be according to the requirements in the Material section.

The work shall be inspected and tested to confirm the acceptability of the fabrication, as follows:

- a) On completion of fabrication, all welds shall be visually inspected.
- b) The following connections shall be tested by magnetic particle testing for steel:
 - i. Column to base plate, stiffeners to column, and stiffeners to base plate for the cantilever, tri-chord, variable message and monotube overhead sign support structures.
 - ii. Cantilever sign support arm to leg connection plates, stiffeners to arm connection plate, and stiffeners to leg connection plate.
- c) All longitudinal groove welds shall be tested prior to assembly of any component to the legs using ultrasonic testing methods. The length and location of welds to be tested shall be as follows:
 - i. The first 2 m of the leg measured from the base plate of tri-chord and monotube overhead sign support structures.
 - ii. The full length of the legs of the cantilever sign support structures.
- d) All circumferential welds shall be tested using ultrasonic testing methods.
- e) All full penetration groove welds at the 8-chord crank locations of the aluminum end panels of the variable message sign support structures shall be tested using ultrasonic testing methods.

A written inspection report of the observations and tests shall be issued to the Contractor.

915.07.07.03 Field Inspection

915.07.07.03.01 Erected Sign Structure Inspection

An inspector shall be provided and in attendance to observe the erection operation and to report on compatibility of anchor layout and holes in the base plate and the general alignment, fit up, and bolting, including confirmation that the tolerance as specified in the Contract Documents between the first diagonal and the corbel is maintained in the tri-chord sign support structure.

The inspector shall visually inspect all components for dents, cracks, ruptures, and loose or improperly fitted clamps and fasteners, including tensioning of fasteners, as well as the presence of all drain and vent holes as specified in the Contract Documents.

A written inspection report of the observations shall be issued to the Contractor.

915.07.07.03.02 Concrete Inspection

The concrete shall be according to the submitted mix design and meet the specification requirements for air content, slump, temperature, concrete strength, and delivery time.

Testing of concrete for air content, slump, and temperature; concrete strength; and casting of cylinders shall be carried out according to OPSS 904.

When early strength of the concrete is to be established, additional cylinders shall be cast.

A written inspection report of the observations and tests shall be issued to the Contractor.

915.07.07.04 Coating Inspection

Coating inspection shall be according to OPSS 911.

A written inspection report of the observations and tests shall be issued to the Contractor.

915.07.07.05 Inspection Reports

The Contractor shall submit 4 copies of all inspection reports to the Contract Administrator within 7 Days after inspection.

Inspection reports shall bear the seal and signature of an Engineer.

915.07.08 Interim Inspections

915.07.08.01 Interim Inspection After Construction of Footings

Upon completion of the construction of the footings, and prior to erection of overhead sign support structures, an Engineer shall conduct an interim inspection of the work to verify that the footings have been constructed in general conformance with the Working Drawings and as specified in the Contract Documents, including requirements for the location, top of footing elevation, anchorage layout, and surface finished to the specified tolerances, and issue the Contractor written permission to proceed with the work.

915.07.08.02 Interim Inspection After Fabrication of Components

Upon completion of fabrication of overhead sign support structure components, and prior to erection, an Engineer shall conduct an interim inspection of the work to verify that the fabrication of the sign support structure components has been carried out in general conformance with the Working Drawings and as specified in the Contract Documents, and issue the Contractor written permission to proceed with the work.

915.07.09 Repair of Sign Support Structures

915.07.09.01 General

This shall only apply to rehabilitation and refurbishment of existing sign support structures.

915.07.09.02 Steel

Salvaged steel components may be used as specified in the Contract Documents. A written certification bearing the seal and signature of an Engineer shall be submitted to the Contract Administrator certifying that salvaged components are defect free and are according to the Contract Documents.

915.07.09.03 Aluminum

Cracked or ruptured welds may be repaired. Distorted, cracked, or ruptured members or components shall be replaced subject to approval by the Contract Administrator as specified in the Contract Documents. Salvaged members shall not be used.

915.07.09.04 Inspection

An inspection of the repairs and replaced components shall be completed as specified in the Quality Control subsection.

915.07.10 As-Built Drawings

For overhead sign support structures, as-built drawings shall be prepared and submitted to the Contract Administrator in a reproducible format prior to final acceptance of the work and shall include the following information:

- a) All work incorporated in the completed structure that required the submission of Working Drawings.
- b) All changes that have been made from the original Contract Documents.

The as-built drawings shall bear the seal and signature of an Engineer.

915.07.11 Certificate of Conformance Upon Completion of the Work

Upon completion of the erection of the sign support structure, the Contractor shall submit to the Contract Administrator a certificate of conformance sealed, signed, and dated by the Quality Verification Engineer. The certificate shall state that the Work has been completed in general conformance with the Working Drawings and as specified in the Contract Documents.

915.07.12 Management of Excess Material

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

915.08 QUALITY ASSURANCE

915.08.01 General

The Owner, at its discretion, may choose to do inspection, testing, and sampling in the fabricating shop and field to confirm that the materials supplied, the fabrication, and the erection have been completed as specified in the Contract Documents.

The Contractor shall provide a free and safe access, and protection from the weather for inspection and testing of materials and structural components, during all aspects of the fabrication, delivery, and erection of the sign support structures, at no additional cost to the Owner.

915.09 MEASUREMENT FOR PAYMENT

915.09.01 Actual Measurement

915.09.01.01 Sign Support Footings

For measurement purposes, a count shall be made of the number of sign support footings installed.

915.09.01.02 Sign Support Structures

For measurement purposes, a count shall be made of the number of sign support structures installed.

915.09.01.03 Attachment of Signs

For measurement purposes, a count shall be made of the number of signs installed.

915.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

915.10 BASIS OF PAYMENT

915.10.01 Concrete in Ground Mounted Static Sign Support Footings, Tri-Chord and Cantilever - Item
Concrete in Median Mounted Static Sign Support Footings Tri-Chord and Cantilever - Item
Concrete in Ground Mounted Variable Message Sign Support Footings - Item
Concrete in Median Mounted Variable Message Sign Support Footings - Item
Concrete in Steel Monotube Overhead Sign Support Footings - Item
Concrete in Steel Column Breakaway Sign Support Footings - Item
Concrete in Steel Column Non-Breakaway Sign Support Footings - Item
Tri-Chord Static Sign Support Structures, Span in Metres - Item
Cantilever Static Sign Support Structures, Class - Item
Steel Monotube Overhead Sign Support Structures, Span in Metres - Item
Variable Message Sign Support Structures, Span in Metres - Item
Steel Column Breakaway Sign Support Structures - Item
Steel Column Non-Breakaway Sign Support Structures - Item
Wood Column Breakaway Sign Support Structures - Item
Wood Column Non-Breakaway Sign Support Structures - Item
Aluminum Bridge Mounted Sign Support Structures - Item
Repair of Existing Structure - Item
Attachment of Sign - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

For payment purposes, the fabrication and delivery of the sign support structures to the work site shall constitute 60% of the work of the tender item.

Replacement of aluminum components that were cracked, ruptured, or damaged during fabrication or erection shall be at no additional cost to the Owner.

Appendix 915-A, November 2014
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

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

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Standard for galvanized fasteners. (915.05.03)
- Clamp details. (915.05.04)
- Standard for steel. (915.05.05)
- Concrete compressive strength. (915.05.06)
- Grade of wood. (915.05.08)
- Anchorage assembly bolt, stud, strut, coil, and galvanizing requirements. (915.05.09)
- Electrical duct and fitting requirements. (915.05.11)
- Granular backfill type. (915.05.12)
- Coating requirements. (915.05.13, 915.07.01.02.04)
- Site identification number, maximum sign area, and design wind pressure for each sign support. (915.07.01.04)
- Footing locations. (915.07.02.01)
- Excavation lines and grades. (915.07.02.02)
- Anchorage assembly level tolerances. (915.07.02.05)
- Rigid duct requirements in footings. (915.07.02.06)
- Concrete footing elevations. (915.07.02.07)
- Bolted field splices. (915.07.03.05)
- Fastener torque requirements. (915.07.03.06)
- Roadside sign support footing locations, dimensions, and elevations. (915.07.04.01)
- Steel column tolerances. (915.07.04.02.02)
- Steel column breakaway type top surface of the friction plate elevation. (915.07.04.02.03)
- Wood column tolerances. (915.07.04.03.01)

Appendix 915-A

- Site trimming and finishing around footings. (915.07.05)
- Locations of signboards to be installed by the Contractor. (915.07.06)
- Drain and vent hole locations. (915.07.07.03.01)
- Use of salvaged steel components. (915.07.09.02)

The designer should determine if the following is required and, if so, specify it in the Contract Documents:

- If ground lugs, fuse clips, and access nipples for wiring are to be installed during shop fabrication. (915.07.01.03)
- Delivery requirements for signboard chord clamps. (915.07.01.05.02)
- Rigid duct sleeves. (915.07.02.06)

OPSS 915 contains information that is not used by municipalities in their Contracts. To ensure completeness of the municipal Contract Documents, the designer should invoke Appendix 915-B. The appendix contains information that modifies OPSS 915 so it can be used by a municipality in its Contracts.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

Appendix 915-B, November 2014

FOR USE IN MUNICIPAL CONTRACTS, WHEN REFERENCED IN THE CONTRACT DOCUMENTS

Note: This is a non-mandatory Additional Information Appendix intended to provide supplementary requirements for the OPS specification in a municipal contract, when the appendix is invoked by the Owner. It is written in mandatory language to permit invoking it by reference in the Contract Documents. If the appendix has not been invoked by reference in the Contract Documents, it does not apply.

Supplemental Requirements for Using OPSS 915 in Municipal Contracts

OPSS 915, Sign Support Structures, is amended as follows:

915.03 DEFINITIONS

Section 915.03, the definition for Certificate of Conformance is deleted in its entirety and replaced with the following:

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

Section 915.03, the definition for Quality Verification Engineer is deleted in its entirety.

915.04.02.02 Working Drawings for Sign Support Structures

The first paragraph of clause 915.04.02.02 is deleted in its entirety and replaced by the following:

The Contractor shall submit 5 sets of Working Drawings to the Contract Administrator at least 14 Days prior to commencement of fabrication of overhead sign support structures.

915.04.02.05 Erection Procedures for Overhead Sign Support Structures

The first paragraph of clause 915.04.02.05 is deleted in its entirety and replaced by the following:

The Contractor shall submit 5 copies of the erection procedures to the Contract Administrator at least 14 Days prior to the commencement of overhead sign support structure erection.

915.04.02 Submission Requirements

Clause 915.04.02 is amended by the addition of the following:

915.04.02.09 Return of Submissions - Working Drawings and Erection Procedures

Two copies of each submission shall be returned as one of the following:

- a) Stamped with the wording that allows for permission to construct. In this case, work can commence on receipt of the working drawings or erection procedures by the Contractor.
- b) Stamped with the wording that allows for permission to construct as noted. In this case, work can start on receipt of the working drawings or erection procedures by the Contractor. The working drawings or erection procedures shall be updated as noted and shall be sealed and signed by the design Engineer and the design-checking Engineer stating the drawings have been revised according to the noted comments.
- c) Showing only required changes. In this case, the working drawings or erection procedures shall be updated as required and the submission process repeated.

Appendix 915-B

915.07.11 Certificate of Conformance Upon Completion of the Work

Clause 915.07.11 is deleted in its entirety and replaced by the following:

915.07.11 Certificate of Conformance

Upon completion of the erection of the sign support structure, the Contractor shall submit to the Contract Administrator a certificate of conformance bearing the seal and signature of an Engineer. The certificate shall state that the work has been completed in general conformance with the Working Drawings and as specified in the Contract Documents.



**CONSTRUCTION SPECIFICATION FOR
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 installation and modification of deck joint assemblies and the placing of preformed seals, joint fillers, joint seals, joint sealing compounds, and waterstops.

920.01.01 Specification Significance and Use

This specification has been developed for use in provincial- and municipal-oriented Contracts. The administration, testing, and payment policies, procedures, and practices reflected in this specification correspond to those used by many municipalities and the Ontario Ministry of Transportation.

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

920.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

920.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 501	Compacting
OPSS 904	Concrete Structures
OPSS 914	Waterproofing Bridge Decks with Hot Applied Asphalt Membrane
OPSS 922	The Installation of Bearings
OPSS 929	Abrasive Blast Cleaning - Concrete Construction

Ontario Provincial Standard Specifications, Material

OPSS 1010	Aggregates - Base, Subbase, Select Subgrade, and Backfill Material
OPSS 1204	Polyvinyl Chloride Waterstops
OPSS 1210	Deck Joint Assemblies
OPSS 1212	Hot Poured Rubberized Asphalt Joint Sealing Compound
OPSS 1302	Water
OPSS 1308	Joint Filler In Concrete
OPSS 1350	Concrete - Materials and Production

ASTM International

C 494M-99a	Standard Specification for Chemical Admixtures for Concrete
C 1017M-98	Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete
D 1056-00	Standard Specification for Flexible Cellular Materials, Sponge or Expanded Rubber

920.03

DEFINITIONS

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

Armouring Angle means as defined in OPSS 1210.

Bearing means as defined in OPSS 922.

Block-out means a cavity created to permit the installation of deck joint assemblies.

Elastomer means as defined in OPSS 1210.

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

Joint Seal means ethyl vinyl acetate foam.

Joint Sealing Compound means a hot applied material, that is not preformed, used to seal a joint.

Nosing Angle means as defined in OPSS 1210.

Preformed Seal means as defined in OPSS 1210.

Product Drawings means drawings prepared by the manufacturer that have been approved by the Owner for use with the product.

Trial Installation means an installation designated by the Owner for the purpose of proving the performance of a particular joint system.

Upturn means an upward vertical change in direction of the seal at the gutter lines.

920.04

DESIGN AND SUBMISSION REQUIREMENTS

920.04.01

Design Requirements

920.04.01.02

Deck Joint Assembly Working Drawings

920.04.01.02.01

Drawing Content

The deck joint assembly Working Drawings shall clearly indicate the following:

- a) Material properties.
- b) Dimensions.
- c) Connection attachments.
- d) Injection hose system components and name of approved injection company.
- e) Shop, field, and stage construction splices.
- f) Fasteners and accessories.
- g) Installation details.

- h) Individual alpha-numeric identification number for each stage of installation.
- i) Handling procedures including lifting points.
- j) Manufacturer's recommended installation procedure for achieving the required bolt tension specified in the Contract Documents.

The deck joint assembly Working Drawings shall be according to the Contract Documents and product drawings and shall bear the seal and signature of an Engineer with 5 years experience in either or both of the fabrication or installation of expansion joints certifying conformance with the Contract Documents and product drawings.

920.04.01.02.01.01 Deck Joint Assembly Modification

In addition to the requirements of the previous clause, where a deck joint assembly is to be placed over an existing joint, the deck joint assembly Working Drawings shall show all connection details between the new and the existing deck joint assemblies.

920.04.02 Submission Requirements

920.04.02.01 Notice of Manufacturer

The Contractor shall notify the Contract Administrator, in writing, of the name and address of the manufacturer of the deck joint assembly within 30 Days of the Contract award.

920.04.02.02 Submissions of Drawings

Five sets of the deck joint assembly Working Drawings and 2 copies of the product drawings shall be submitted to the Contract Administrator 3 weeks prior to fabrication.

920.04.02.02.01 Return of Submissions

Two copies of the deck joint assembly Working Drawings to be returned shall be marked as one of the following:

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

In this case, work can commence on receipt of the drawing by the Contractor. A copy of these drawings shall be available at the site prior to and during construction.

- b) Stamped with the wording that allows for permission to construct as noted.

In this case, work can start on receipt of the drawings by the Contractor. The drawings shall be updated as noted and shall have a stamp affixed that is signed by an Engineer stating the drawings have been revised according to the noted comments. A copy of the stamped updated drawings shall be available at the site prior to and during construction.

- c) Showing only required changes.

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

920.04.02.03 Manufacturer's Installation Procedures

Two copies of the manufacturer's recommended installation procedures for the deck joint assemblies and data sheets shall be submitted to the Contract Administrator, 7 Days prior to the application of the hot applied joint sealing compound and trial installations of the deck joint assembly.

920.04.02.04 Cold Weather Protection for Epoxy Injection

One week prior to the commencement of epoxy injection of the deck joint assembly in cold weather, a description of the method to be used to control the concrete temperature shall be submitted to the Contract Administrator. The submission shall be accompanied by samples of insulation when requested by the Contract Administrator. The description shall contain the following information:

- a) Weather conditions for which the description applies.
- b) Type of insulation, R value, and number of layers to be used.
- c) Description of housing and heating.
- d) Method of protection employed to effectively maintain the concrete temperature above 5 °C in the expansion joint blockout during the injection and continuously for a period of 48 hours after epoxy injection.

920.04.02.05 Field Dimensions

Prior to the commencement of fabrication of the deck joint assembly, the Contractor shall submit drawings to the Contract Administrator indicating the actual dimensions at the existing deck joint assembly locations.

920.05 MATERIALS

920.05.01 Preformed Seals

Preformed seals shall be according to OPSS 1210.

920.05.02 Joint Fillers

Joint fillers shall be according to OPSS 1308.

920.05.03 Joint Seals and Joint Sealing Compounds

Joint seals shall be according to ASTM D 1056 for ethyl vinyl acetate foam. The top surface of the ethyl vinyl acetate foam shall be embossed with the manufacturer's name and product identification.

Joint sealing compounds shall be according to OPSS 1212.

920.05.04 Lubricant

The lubricant shall be water soluble, non-adhesive, and non-staining. Lubricants used between the steel components and preformed seals shall not be deleterious to the joint materials or the surrounding concrete.

920.05.05 Deck Joint Assemblies

Deck joint assemblies shall be according to OPSS 1210.

920.05.06 Concrete

Concrete in which the deck joint assemblies are embedded shall be according to OPSS 1350 with a nominal minimum 28-Day compressive strength of 30 MPa, except as amended below:

- a) The nominal maximum size of coarse aggregate for concrete shall be 13.2 mm.
- b) Superplasticized concrete shall be used in expansion joints with cross slopes of 4% or less.

The Contractor shall supply a certificate from the manufacturer of the superplasticizer verifying that the superplasticizer meets the following requirements:

- i. Is according to ASTM C 494M and C 1017M.
 - ii. Contains no chlorides.
 - iii. Is compatible with the cementing materials and all other materials in the concrete.
- c) The concrete shall have an initial slump of 40 mm $\pm$ 20 mm. This slump shall be increased when required by the addition of the superplasticizer at the site according to the written instructions of the superplasticizer manufacturer. After the addition of the superplasticizer, the air content shall be 8.0% $\pm$ 1.5% and the slump shall be 150 mm $\pm$ 30 mm.

920.05.07 Bonding Agent

Bonding agent shall be according to OPSS 904.

920.05.08 Granular Materials

Granular A shall be according to OPSS 1010.

920.05.09 Antiseize Compound

Antiseize compound shall be according to OPSS 1210.

920.05.10 Water

Water shall be according to OPSS 1302.

920.05.11 Waterstops

Waterstops shall be according to OPSS 1204.

920.07 CONSTRUCTION

920.07.01 Installation of Deck Joint Assemblies

920.07.01.01 General

Concrete work is part of this item and except as specified herein shall be according to OPSS 904.

Deck joint assemblies shall be installed according to the stamped deck joint assembly Working Drawings.

Any damage to the corrosion protection system, including surface areas of field welds, shall be repaired with two coats of brush applied zinc rich coating applied according to the coating manufacturer's recommendations.

The threaded portion of the bolts and the underside of bolt heads shall be liberally coated with an antiseize compound immediately prior to installation.

The bolts that have been fully tensioned and require removal after final installation shall not be reused to fasten the clamping bars.

For modular expansion joint installation, the Contractor shall inform the joint manufacturer 7 Days prior to the joint installation, so that the manufacturer's representative is present on site during the installation to advise on the proper installation procedure.

920.07.01.01 Traffic Restrictions

Traffic, including construction traffic, shall not be permitted on any part of each stage of the deck joint assembly until all of the following conditions are met:

- a) Concrete has cured for 7 Days.
- b) Concrete has attained a minimum compressive strength of 25 Mpa.
- c) Epoxy injection has been completed.
- d) Epoxy has cured for a minimum of 24 hours.
- e) For cold weather, epoxy has cured for 48 hours after epoxy injection or the curing time as specified in the manufacturer's data sheet.
- f) For Type A joints, the clamping bars have been installed.

920.07.01.02 Protection

The deck joint assembly shall be lifted by nylon slings placed at the lifting points indicated on the stamped deck joint assembly Working Drawings.

During storage, the deck joint assembly shall be protected from dirt and deleterious materials, and stored so that distortion cannot occur. The deck joint assembly shall be supported on wood blocking spaced a maximum of 2 m apart.

920.07.01.03 Splicing

The location and number of field and stage construction splices and method of splicing of metal components shall be as detailed on the stamped deck joint assembly Working Drawings. For new construction, when the length of the expansion joint is greater than 15 m and a splice is required, a splice shall be located at a lane demarcation line near the centre line of the structure.

The preformed seal shall be continuous with no splices.

920.07.01.04 Placing

The deck joint assemblies shall be placed after the asphalt paving operation has been completed.

A block-out shall be formed for the deck joint assembly during concrete construction of the deck, ballast wall, and barrier wall. When new barrier walls are to be constructed, bulkheads shall be used to form block-outs in the barrier wall for the deck joint assemblies. The dimensions of the block-out in the barrier wall shall not be greater than those of the block-out in the deck and ballast wall, except for the modular joints in structures. The removal of existing concrete required to prepare the block-out shall be carried out prior to the paving operation.

Prior to filling the block-out, the expansion joint gap shall be plugged. The method used to plug the gap shall accommodate the anticipated movement and retain the fill material in the block-out during the period of traffic maintenance. The block-out shall be filled to the top of the deck prior to asphalt paving with granular A compacted according to OPSS 501.

When traffic is to be maintained over the block-out prior to asphalt paving, the granular A shall be capped with 50 mm of bituminous cold mix or hot mix. The top surface of the bituminous mix shall be maintained smooth and level with adjacent concrete and shall not ravel.

The limits of the block-out shall be accurately marked to be visible after paving. The paving operation shall be continuous over the area, which includes the deck, approach slabs, and 20 m beyond the end of each approach slab. Transverse joints in the asphalt pavement shall not be permitted.

Except when traffic is to be maintained over the unfinished joint, all material used to fill the block-out shall be removed within 5 Working Days after the block-out material is placed. The new asphalt pavement shall be sawcut full depth at the limits of the block-out. The asphalt from the block-out areas shall be removed and temporary wood angles with a minimum thickness of 19 mm shall be placed to protect the sawcut asphalt edges for the full depth of asphalt. Asphalt residue shall be cleaned from the reinforcing bars. All the material used to plug the expansion gap and to fill the block-out shall then be removed to the depth of the bearing seat.

Prior to placing the reinforcing steel, the concrete faces of the block-out shall be abrasive blast cleaned according to OPSS 929. After completion of this work, the deck joint assembly shall be placed in the block-out 3 mm below the elevation of asphalt pavement and in the position specified in the deck joint assembly Working Drawings.

Immediately prior to placing the concrete in the block-out, the top setting devices shall be adjusted to give the specified setting width required by the stamped deck joint assembly Working Drawings. The setting devices shall then be tightened and the deck joint assembly secured at the correct width, line, and grade by welding the loop anchors and stud anchors to the reinforcing bars. The location of these welds shall be at least 100 mm below the top of the end dams and the spacing shall be at approximately 500 mm centres.

Abrasive blast cleaned areas shall have the concrete placed in the block-out within 48 hours of being cleaned or shall be reblasted. Abrasive blast cleaned concrete surfaces shall receive a bonding agent immediately prior to placing concrete. Concrete shall be placed and consolidated to minimize voids under the deck joint assembly and shall be hand finished with a wood float. All steel surfaces that are to be in contact with the preformed seal shall be protected during placing of concrete.

After concrete construction, the exposed faces of the structural steel shapes shall be cleaned to remove any concrete and deleterious material. The setting devices shall be flame cut at the gap between two to four hours after the concrete placement.

The setting device bolt holes for all nosing angles, as well as for the armouring angles of the joints shall be drilled to a depth of 20 mm, air blast cleaned, and immediately filled with epoxy.

After installation of the deck joint assemblies, the Contractor shall sawcut a 20 mm wide groove for the full depth of asphalt adjacent to each steel nosing angle. If the previously sawcut face is undamaged and within 5 mm of the specified location, the Contractor may elect to form the groove. The grooves shall be cleaned, dried, and filled with hot poured rubberized joint sealing compound according to OPSS 914.

When an expansion joint system is specified in the Contract Documents with an approved elastomeric concrete, the mixing, placing, and curing requirements of elastomeric concrete shall be according to the manufacturer's specifications.

920.07.01.05 Epoxy Injection

920.07.01.05.01 General

Epoxy shall be injected into the injection hose system once concrete in the expansion joint blockouts has been in place for a minimum of 7 Days and has a minimum compressive strength of 25 MPa.

The epoxy shall be kept at a temperature of $20\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$ prior to its use.

920.07.01.05.02 Injection Method

Only the supplier of the expansion joint system or his approved agent shall inject the epoxy used in the injection hose system.

Epoxy shall be mixed and pressure injected according to the manufacturer's specifications.

Injection shall start at the fitting at one end of a two-metre section of hose to initially fill the hose and continue until the epoxy emits at the other fitting of the same section. Injection shall then alternate at both fittings of the same section until the epoxy emits from the voids in the concrete or at the interface between the steel angles and concrete or both. The injection ports shall then be plugged.

The above procedure shall be repeated in each section of hose until the full length of the expansion joint system has been filled with epoxy. The top surface of the blockout shall be thoroughly cleaned to remove any excess epoxy prior to hardening.

After the epoxy has set, all adapters and injection plugs shall be removed and the plugholes filled with epoxy.

The deck joint assembly shall be checked for voids remaining under the angles. Holes shall be drilled in angles when voids are detected and voids and bolt holes shall be filled with epoxy.

920.07.01.05.03 Cold Weather Epoxy Injection Requirements

Epoxy injection shall not be performed in cold weather conditions without protection when the ambient air temperature is below $5\text{ }^{\circ}\text{C}$ or is likely to fall below $5\text{ }^{\circ}\text{C}$ 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 $5\text{ }^{\circ}\text{C}$ prior to the commencement of the injection. The temperature shall be maintained at a minimum of $5\text{ }^{\circ}\text{C}$ for a period of 48 hours after injection or the curing time as specified in the manufacturer's data sheet.

920.07.02 Modification of Deck Joint Assemblies

920.07.02.01 General

The requirements of the Installation of Deck Joint Assemblies subsection apply to the Modification of Deck Joint Assemblies subsection.

Prior to installation of a new deck joint assembly and new reinforcing bars, the existing reinforcing steel, structural steel, and existing concrete against which new concrete is to be placed shall be abrasive blast cleaned according to OPSS 929.

When a new joint assembly is to be welded to existing hardware, the surface of the existing hardware that is to be in contact with the new joint assembly shall be abrasive blast cleaned according to OPSS 929.

920.07.02.02 Drilling and Preparation of Holes

The edge of drilled holes shall not be permitted within 50 mm of a concrete edge.

Holes for dowels or anchor bolts embedded in non-shrink grout shall be core drilled, flushed out with water, and air blast cleaned immediately after drilling. Immediately prior to placing non-shrink grout, the hole shall be predampened for one hour with no free water in the hole.

Holes for dowels or anchor bolts embedded in epoxy shall be impact drilled. The holes shall be cleaned of all deleterious material by air blasting and shall be dry when the epoxy is placed.

Mixing and placing procedures shall be according to the epoxy manufacturer's recommendations.

920.07.03 Repair of Existing Deck Joints

Repair of existing deck joint assemblies shall be according to the Installation of Deck Joint Assemblies and the Modification of Deck Joint Assemblies subsections and as specified in the Contract Documents.

920.07.04 Field Installation of Preformed Seals and Bolted Components

Preformed seals shall be installed in one continuous piece. Seals shall not be bent more than 30 degrees at any one location. The preformed seals and bolted components shall be installed according to the stamped deck joint assembly Working Drawings.

920.07.05 Placing Joint Fillers and Waterstops

Joint fillers and waterstops shall be firmly fixed in position before any concrete is placed so that their final position in the concrete remains as shown in the Contract Documents and are true to line and grade.

Field splicing of waterstops shall be by heat fusion.

920.07.06 Placing Joint Seals and Joint Sealing Compounds

920.07.06.01 Preparation of Joint

Concrete at all joints shall be sound; clean; dry; and free of all dust, debris, and deleterious material.

The joint face shall be true to line so that the joint seal shall bear on the joint face fully and uniformly.

920.07.06.02 Placing Joint Seals

Gaps forming longitudinal joints between structures shall be sealed with a joint seal made of ethyl vinyl acetate foam installed with the laminations horizontal.

Prior to installation of the joint seal, the joint recess shall be abrasive blast cleaned and air blasted according to OPSS 929 to remove laitance and deleterious material.

Adhesive shall be applied liberally to both vertical sides of the joint seal and to both vertical faces of the joint recess. Excess adhesive shall be removed immediately.

The joint seal shall be installed so that it remains below the level of the concrete surface when fully compressed.

The joint seals shall not be field spliced.

920.07.06.03 Placing Hot Poured Rubberized Asphalt Joint Sealing Compounds

Hot poured rubberized asphalt joint sealing compound shall be installed according to OPSS 914, except that the temperature of the air and the materials that are to be in contact with the sealing compound shall be 2 °C or greater at the time of installation.

920.07.07 Trial Installations

For designated trial installations, only deck joint assemblies pre-approved for trial installation by the Owner shall be used. The installation procedures shall be according to the manufacturer's detailed instructions, the Contract Documents, and applicable parts of this specification.

920.07.08 Quality Control

920.07.08.01 Water Test

The air, concrete, and deck joint assembly temperature shall be 2 °C or higher at time of testing.

After the epoxy has set and prior to acceptance, the joint shall be water tested over its entire length when there are no upturns. When there are upturns, the joint shall be tested between the gutter lines. The water shall be continuously ponded for a minimum of one hour, maintaining a minimum depth of 25 mm along the tested length and a minimum depth of 100 mm above the deck joint assembly at the gutter lines. For superelevated decks, only the lower gutter line requires the testing at a depth of 100 mm. The width shall extend 50 mm beyond the concrete dams on both sides of the deck joint assembly. When the staging of traffic is required, the joint shall be tested in overlapping sections.

Leakage of water through the deck joint assembly during this test, including the interface between the preformed seal and the seal retainers, concrete to steel interfaces, and the concrete construction joints, shall constitute failure of the deck joint assembly.

If such failure occurs, the deck joint assembly shall be repaired or replaced and the water test repeated. The method of repair shall be submitted in writing to the Contract Administrator for review prior to commencement of repair work.

Leakage at an elastomeric concrete to steel interface and at an elastomeric concrete to concrete interface, shall require replacement of the elastomeric concrete joint system and the water test repeated.

The water test and any related corrective work shall be completed prior to any seasonal shutdowns. When this is not feasible, a proposal detailing an alternative solution shall be submitted to the Contractor Administrator for approval.

920.07.09 Corrective Work for Initial Acceptance

At the Contractor's expense, all defects identified in the Criteria for Initial Acceptance of the Deck Joint Assembly subsection shall be repaired according to the requirements of this specification and to the satisfaction of the Contract Administrator.

920.07.10 Performance Warranty

920.07.10.01 General

The Contractor shall warrant that the deck joint assemblies have been fabricated and installed according to the specifications and shall be free from deficiency for a period of 2 years from the date of the issuance of the Certificate of Substantial Performance.

The warranty shall expire when both of the following occur:

- a) The two-year warranty period has elapsed.
- b) There are no deficiencies or all deficiencies have been corrected to the satisfaction of the Owner.

When time is required beyond the 2 years for the Contractor to correct any defects, the warranty shall continue until repair or replacement has been completed to the satisfaction of the Owner.

920.07.10.02 Warranty Evaluation

Two months prior to the expiry of the two-year warranty, the Owner shall evaluate the deck joint assembly according to the requirements of the Criteria for Final Acceptance of Deck Joint Assemblies clause. The Owner shall notify the Contractor of the time and date of the inspection. The Contractor shall be present during this inspection.

The Owner shall notify the Contractor of all defects that require corrective work according to the Criteria for Final Acceptance of Deck Joint Assemblies clause.

When there are deficiencies, the deck joint assembly and its installation shall not be accepted until appropriate corrective work has taken place to the satisfaction of the Owner.

920.07.10.03 Final Acceptance

Two weeks prior to the commencement of corrective work of the deck joint assembly, a description of the method to be used for corrective work shall be submitted to the Owner for review and approval. The submission shall be accompanied by a report indicating the cause of each defect.

The Contractor shall repair all defects according to the requirements of this specification and the approved proposal to the satisfaction of the Owner. If the deck joint assembly has to be replaced, its successor shall be an equivalent approved joint. All costs including labour, Equipment, Material, and traffic control shall be at the expense of the Contractor.

All corrective work shall be done within three months of the inspection, unless prevented by seasonal shutdown, in which case, the work shall be done during the first 5 weeks of the following construction season. The Contractor shall provide a minimum of three days notice to the Owner prior to carrying out any corrective work.

920.07.11 Management of Excess Material

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

920.08 QUALITY ASSURANCE

920.08.01 Sampling and Testing

Random sampling and testing shall be performed.

920.08.02 Preformed Seal Sample

A sample shall be taken from the extra length of preformed seal supplied for each joint delivered to the Working Area for testing according to Table 1 in OPSS 1210.

920.08.03**Criteria for Initial Acceptance of Deck Joint Assembly**

On completion of the deck joint assembly installation, the Contract Administrator shall inspect for the following deficiencies:

- a) Defective seals.
- b) Cracks wider than 0.3 mm and voids in concrete end dams.
- c) Defective coating.
- d) Seal not completely held in retainer.
- e) Bolt torque not as specified on the stamped deck joint assembly Working Drawing.
- f) Defective, loose, or missing structural components and welds.
- g) Leakage at interfaces determined according to the Water Test clause.
- h) A line parallel to the centreline of the structure joining the tops of all steel components of the deck joint assembly that deviates from a line parallel to the pavement profile between nosing angles by more than 3 mm, at any location along the length of the expansion joint.
- i) For modular joints, at any location along the length of the deck joint assembly, the relative difference in the opening between the steel retainers exceeds the narrowest width by 6 mm. This dimension shall be measured at the level of the road surface, perpendicular to the centreline of the expansion joint, and at the inner faces of the retainers.
- j) Any portion of the deck joint assembly is extending above the finished road surface.

920.08.04**Criteria for Final Acceptance of Deck Joint Assemblies**

The deck joint assembly shall be inspected by the Owner and shall be accepted, provided the deficiencies listed below do not exist:

- a) Defective seals as a result of material deficiencies.
- b) Defective coating of components as a result of coating application or material deficiencies.
- c) Seal not completely held in retainer.
- d) Loose bolts.
- e) Defective, loose, or missing structural components and welds.
- f) Delaminated or spalled concrete or both.

920.10**BASIS OF PAYMENT****920.10.01****Deck Joint Assemblies, Installation - Item
Deck Joint Assemblies, Modification - Item**

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

920.10.02 Repair of Existing Deck Joints - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

When the repairs are not specified in the Contract Documents, payment for the cost of repairing existing deck joints and of repairing concrete prior to the installation of deck joint assemblies or preformed seals shall be administered as Extra Work.

920.10.03 Preformed Seals, Joint Fillers, Joint Seals, Joint Sealing Compounds, and Waterstops

Payment for the tender items in which preformed seals, joint fillers, joint seals, joint sealing compounds, and waterstops are placed shall include full compensation for all labour, Equipment, and Material to do the work of placing these materials.

Appendix 920-A, November 2012
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

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

Designer Action/Considerations

The following shall be specified in the Contract Documents:

- Deck joint assembly working drawing and bolt tension. (920.04.01.02.01)
- Modification of deck joint assembly. (920.04.01.02.01.01)
- Placement of deck joint assembly. (920.07.01.04)
- Repair of existing deck joint assemblies. (920.07.03)
- Location, line, and grade for installing preformed seals and bolted components. (920.07.05)
- Trial installations of deck joint assemblies. (920.07.07)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 3950.100 Joints, Concrete Expansion and Construction, On Structure



**ONTARIO
PROVINCIAL
STANDARD
SPECIFICATION**

**METRIC
OPSS.MUNI 922
NOVEMBER 2016**

(Formerly OPSS 922, November 2009)

Note: The MUNI implemented in November 2016 replaces OPSS 922 COMMON, November 2009 with no content changes.

**CONSTRUCTION SPECIFICATION FOR
INSTALLATION OF BEARINGS**

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922.01 SCOPE

This specification covers the construction requirements for the installation of bearings.

922.01.01 Specification Significance and Use

This specification has been developed for use in provincial- and municipal-oriented Contracts. The administration, testing, and payment policies, procedures, and practices reflected in this specification correspond to those used by many municipalities and the Ontario Ministry of Transportation.

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

922.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

922.02 REFERENCES

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

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

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

Ontario Provincial Standard Specifications, Material

OPSS 1202 Bearings - Elastomeric Plain and Steel Laminated
OPSS 1203 Bearings - Rotational and Sliding Surface

CSA Standards

A23.1-04/A23.2-04 Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete

ASTM International

C 928-05 Standard Specification for Packaged, Dry, Rapid-Hardening Cementitious Materials for Concrete Repairs

922.03

DEFINITIONS

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

Anchor means a device employed to secure a bearing to the structure or to restrict movement of the structure or both.

Bearing means a structural device that transmits load while permitting translation or rotation or both.

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

Engineer means a Professional Engineer licensed by the Professional Engineers Ontario to practice in the province of Ontario.

Product Drawings means drawings prepared by the manufacturer that have been approved by the Owner for use with the product.

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

Superstructure means all parts of a bridge above the bearings.

922.04

DESIGN AND SUBMISSION REQUIREMENTS

922.04.01

Submission Requirements

922.04.01.01

Layout and Installation Drawings

922.04.01.01.01

General

The Contractor shall submit 3 sets of bearing layout and installation drawings to the Contract Administrator at least 1 week prior to commencement of bearing installation, for information purposes only. An Engineer's seal and signature shall be affixed on the layout and installation drawings verifying that the drawings are consistent with the Contract Documents.

The Contractor shall have a copy of these drawings at the site prior to and during site installation of the bearings.

922.04.01.01.02

Elastomeric Bearings

The layout and installation drawings for elastomeric bearings shall clearly indicate the following:

- a) Bearing layout and orientation.
- b) Dimensions and details of the bearings.
- c) Details of the top or bottom plate, or both, including anchorages or dowels or both.
- d) Installation details.

- e) Load resistance at serviceability and ultimate limit states, including maximum compressive permanent and total loads.
- f) Individual alphanumeric identification of each bearing.

922.04.01.01.03 Rotational and Sliding Surface Bearings

The layout and installation drawings for rotational and sliding surface bearings shall clearly indicate the following:

- a) Bearing layout and orientation.
- b) Top and bottom plate details, including anchorages.
- c) Installation details.
- d) Method of attachment of bearings to the top and bottom plates.
- e) Bearing identification letter and numbers.

922.04.01.02 Jacking

When jacking of the superstructure is specified in the Contract Documents, the Contractor shall submit 3 sets of the jacking drawings to the Contract Administrator at least 1 week prior to commencement of jacking, for information purposes only. The submission shall include the method and location, type, and capacity of jacks to be used; the type and location of the gauges; and the calibration certificates for both the jacks and gauges. An Engineer shall affix his or her seal and signature on the jacking drawings verifying that the drawings are consistent with the Contract Documents and sound engineering practices.

When jacking is not specified in the Contract Documents, the Contractor shall submit 5 sets of the jacking proposal drawings to the Contract Administrator at least 3 weeks prior to the commencement of jacking, for approval. The submission shall include the method and location, type, and capacity of jacks to be used; the type and location of the gauges; and the calibration certificates for both the jacks and gauges and, where necessary, the details of support for the jacks. Proposals shall bear the seals and signatures of the design and checking Engineers.

A copy of each jacking proposal drawing shall be returned as one of the following:

- a) Stamped with the wording that allows for permission to construct. In this case, work can commence on receipt of the drawing by the Contractor.
- b) Stamped with the wording that allows for permission to construct as noted. In this case, work can start on receipt of the drawings by the Contractor. The drawings shall be updated as noted and shall be sealed and signed by an Engineer stating the drawings have been revised according to the noted comments.
- c) Showing only required changes. In this case, the drawings shall be updated as required and the submission process repeated.

When another authority is involved with the Contract, all submissions shall be made at least 5 weeks prior to the commencement of work.

The Contractor shall have a copy of the jacking drawings or the approved jacking proposal drawings at the site prior to and during the jacking operation.

922.05 MATERIALS

922.05.01 Bearings

Bearings shall be according to OPSS 1202 or OPSS 1203 and as specified in the Contract Documents.

922.05.02 Grout

Grout shall be cement based, non-shrink, non-staining, and approved by the Owner.

Grout shall have a minimum nominal 7-Day compressive strength of 35 MPa.

922.07 CONSTRUCTION

922.07.01 General

The bearings shall be protected from damage, distortion, excessive heat, and deleterious matter during the handling, transportation, storage, and installation.

The bearings shall not be disassembled by the Contractor without the permission of the bearing supplier. The bearing supplier's representative shall be present during disassembly and reassembly.

Upon completion of the structure, the top and bottom surfaces of the bearings shall be in full contact with the structure.

Grouting operations shall be according to the manufacturer's recommendations, except that the temperature of the air, concrete, and bearings shall not be less than 10 °C at the time of grouting and shall be maintained at not less than 10 °C for a minimum of 96 hours after grout is placed.

922.07.02 Bearing Seats

The bearing seats shall be finished level and to an elevation established by subtracting the thickness of the bearings supplied from the top of bearing elevations specified in the Contract Documents. For elastomeric bearings, the finish of the concrete surface shall be smooth and not vary more than 1 mm along a straightedge placed in any direction across an area that extends at least 25 mm beyond the outside limits of the bearing. For other types of bearings, deviation along the straightedge shall not vary more than 3 mm.

Any concrete surface area prepared by grinding shall not allow water to pond in the area. For elastomeric bearings, the bearing seat areas prepared by grinding shall be intentionally roughened such that the surface has an equivalent to trowel finish. All surface areas shall be inspected and deemed acceptable by the Contract Administrator prior to installation of bearings.

922.07.03 Alignment

The longitudinal and transverse centrelines of the bearings shall be installed within ± 3 mm of the position specified in the Contract Documents. The centreline of the bearing along the direction of movement shall be parallel to the direction of movement of the bridge at that bearing location.

922.07.04 Installation of Anchors

The diameter, length, and material of the anchor and the diameter and depth of the anchor hole shall be as specified in the Contract Documents.

Where coring of the bearing seats to receive anchors is permitted, care shall be taken to ensure that the coring is done without damaging or cutting the steel reinforcement. Where permitted, coring shall not commence earlier than 3 weeks prior to bearing installation. In lieu of coring, the holes may be formed.

The holes shall be protected against entry of moisture and shall be completely filled with grout, when the anchors are installed.

922.07.05 Grouting

Where the anchors for rotational and sliding surface bearings require core drilling or preformed holes, the bearings shall be bedded over their entire area on grout that does not contain any voids. The use of permanent shims to achieve the theoretical elevation at the top of the bearing shall not be allowed.

The thickness of the grout bedding for rotational and sliding surface bearings shall be 12 mm $\pm$ 3 mm. The substrate shall be roughened by bushhammering, cleaned, and prewetted prior to grouting. Transfer of superstructure load to the bearings shall not be allowed until the grout has reached a minimum strength of 30 MPa.

The grout material shall be mixed, handled, and cured according to the manufacturer's instructions.

Elastomeric bearings shall not be placed directly on grout.

922.07.06 Tolerances

Bearings shall be set level to within a 500H:1V slope in any direction. The top of the bearing shall be set at the theoretical elevation specified in the Contract Documents, within the following tolerances:

Concrete deck and precast I-type girders	$\pm$ 5 mm
Steel plate girders	0 to + 3.0 mm
Steel and precast concrete box girders	0 to + 2.0 mm

922.07.07 Temporary Attachments

Temporary clamping devices shall be used to maintain correct orientation and setting and to prevent movement or separation of the bearing components during the handling, transportation, and installation. The clamping devices shall not be used for lifting or suspending the bearings. Clamping devices shall be removed after each bearing is in its final position, with all permanent connections made, and after all grout and concrete in contact with the bearing have been placed.

922.07.08 Jacking

Jacking operations shall be carried out under the direct supervision of an Engineer.

The lifting or lowering of the structure shall be carried out in one uniform and synchronized jacking operation. At no time during jacking operations shall the difference between any of the jacking points be more than 3 mm at the same abutment or pier cap.

When jacking is required in order to adjust the bearings, the structure shall be jacked the minimum amount required to allow the bearings to come back to a vertical position.

922.07.09 Quality Control

922.07.09.01 Certificate of Conformance

A completed Certificate of Conformance shall be submitted to the Contract Administrator upon completion of the work. The Qualification Verification Engineer's seal and signature shall be affixed on the completed Certificate of Conformance confirming that the following are in general conformance with the requirements of the layout and installation drawings, Working Drawings, product drawings, and Contract Documents for the bearings:

- a) Fabrication
- b) Installation
- c) Adjustments, when applicable

922.07.09.02 Sampling and Supplying of Bearings

After the bearings have been fabricated, the Contractor shall notify the Contract Administrator in writing of the identification and availability of the bearings.

Where strip bearings have been specified for precast boxes placed side-by-side, each bearing strip shall be supplied at least 600 mm longer than required. A sample, 600 mm in length, shall be cut in the field from one end of each strip bearing and supplied for testing.

Elastomeric bearings beyond the number of bearings specified for installation shall be supplied as specified in the Contract Documents.

All bearings shall be available for sampling either at the project site or at a location acceptable to the Contract Administrator. Sample bearings for testing purposes shall be selected by the Contract Administrator from all the bearings of each size and thickness fabricated for the Contract. The Contract Administrator shall advise the Contractor in writing which bearings have been selected for testing. The Contractor shall deliver these bearings to the location specified in the Contract Documents.

922.07.09.03 Grout Testing

Three 7-Day compressive strength cubes shall be made and tested according to ASTM C 928 for each day that grout is being placed.

For early strength testing, additional cubes shall be tested.

922.08 QUALITY ASSURANCE

922.08.01 Testing

The Contractor shall allow 60 Days from the time of submission of elastomeric bearings for the Owner's testing program.

The number, type, and size of elastomeric bearing samples to be selected for destructive testing shall be as specified in the Contract Documents.

922.08.02 Rejection

If a sample plain elastomeric bearing fails, all plain elastomeric bearings represented by that sample shall be rejected.

If the number of laminated elastomeric bearings specified is less than 10, failure of the sample bearing shall mean that all laminated elastomeric bearings are rejected.

If the number of laminated elastomeric bearings specified is 10 or more, failure of a sample bearing shall mean that all laminated elastomeric bearings of that size and thickness are rejected.

Rejected bearings, whether installed or not, shall be removed from the job site. Bearings supplied as replacements for rejected bearings shall be sampled, tested, and approved or rejected on the same basis as the original bearings.

922.09 MEASUREMENT FOR PAYMENT

922.09.01 Bearings

For measurement purposes, a count shall be made of the number of the bearings installed and of the bearings supplied for destructive testing. Alternatively, bearings may be a lump sum item.

922.10 BASIS OF PAYMENT

922.10.01 Bearings - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the Work.

When bearings are a lump sum item, payment at the Contract price for the tender item Bearings shall include full compensation for the bearings supplied for destructive testing.

Appendix 922-A, November 2009 FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

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

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- When jacking of a structure is required. (922.04.01.02)
- Type of bearing. (922.05.01)
- Top of bearing elevation. (922.07.02)
- Bearing location. (922.07.03)
- Bearing anchor dimensions and material. (922.07.04)
- Bearing anchor hole dimensions. (922.07.04)
- Number of sample bearings and delivery location of samples for testing. (922.07.09.02)
- Number, type, and size of elastomeric bearings for destructive testing. (922.08.01)

OPSS 922 contains information that is not used by municipalities in their Contracts. To ensure completeness of the municipal Contract Documents, the designer should invoke Appendix 922-B. The appendix contains information that modifies OPSS 922 so it can be used by a municipality in its Contracts.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

Appendix 922-B, November 2009

FOR USE IN MUNICIPAL CONTRACTS, WHEN REFERENCED IN THE CONTRACT DOCUMENTS

Note: This is a non-mandatory Additional Information Appendix intended to provide supplementary requirements for the OPS specification in a municipal contract, when the appendix is invoked by the Owner. It is written in mandatory language to permit invoking it by reference in the Contract Documents. If the appendix has not been invoked by reference in the Contract Documents, it does not apply.

Supplementary Requirements for Using OPSS 922 in Municipal Contracts

OPSS 922, Installation of Bearings, is amended as follows:

922.03 DEFINITIONS

Section 922.03 is amended by the deletion of the definitions for Certificate of Conformance and Quality Verification Engineer.

922.04.01.01 General

Clause 922.04.01.01.01 is deleted in its entirety and replaced by the following:

The Contractor shall submit 5 sets of bearing layout and installation drawings to the Contract Administrator at least 3 weeks prior to commencement of bearing installation, for information purposes only. An Engineer shall affix his or her seal and signature on the layout and installation drawings verifying that the drawings are consistent with the Contract Documents and sound engineering practices.

The Contractor shall have a copy of these drawings at the site prior to and during site installation of the bearings.

922.04.01.02 Jacking

Clause 922.04.01.02 is deleted in its entirety and replaced by the following:

When jacking of the superstructure is specified in the Contract Documents or is required due to the Contractor's method of construction, the Contractor shall submit 5 sets of the jacking or jacking proposal drawings to the Contract Administrator at least 3 weeks prior to the commencement of jacking, for review. The submission shall include the method and location, type, and capacity of jacks to be used; the type and location of the gauges; and the calibration certificates for both the jacks and gauges and, where necessary, the details of support for the jacks.

All jacking drawings shall bear the seal and signature of an Engineer verifying that the drawings are consistent with the Contract Documents and sound engineering practices.

Proposals shall bear the seals and signatures of the design and checking Engineers.

Appendix 922-B

922.04.01 Design and Submission Requirements

Subsection 922.04.01 is amended by the addition of the following:

922.04.01.03 Return of Submissions

Two copies of each submission shall be returned as one of the following:

- a) Stamped with the wording that allows for permission to construct. In this case, work can commence on receipt of the drawings by the Contractor.
- b) Stamped with the wording that allows for permission to construct as noted. In this case, work can start on receipt of the drawings by the Contractor. The drawings shall be updated as noted and shall be sealed and signed by an Engineer stating the drawings have been revised according to the noted comments.
- c) Showing only required changes. In this case, the drawings shall be updated as required and the submission process repeated.

When another authority is involved with the Contract, all submissions shall be made at least 5 weeks prior to the commencement of work.

The Contractor shall have a copy of the stamped updated or accepted drawings at the site during any jacking operation.

922.07.09.01 Certificate of Conformance

Clause 922.07.09.01 is deleted in its entirety.



**CONSTRUCTION SPECIFICATION FOR
STRUCTURE REHABILITATION - CONCRETE REMOVAL**

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928.01 SCOPE

This specification covers the mechanical requirements for the removal of concrete from existing structures, except by means of pressurized water, in order to facilitate structure rehabilitation.

928.01.01 Specification Significance and Use

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

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

928.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

928.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 905 Steel Reinforcement for Concrete

CSA Standards

CAN/CSA S6-06 Canadian Highway Bridge Design Code

928.03 DEFINITIONS

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

Concrete Crusher means a piece of equipment fitted with a hydraulic attachment, such as a scissor type jaw, used for the removal of concrete.

Concrete Removal - Full Depth means concrete removals that typically apply to full or partial length removals of entire thickness of curbs, sidewalks, medians, wingwalls, barrier walls, 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, the top and inside faces of concrete barrier walls and parapet walls, sidewalks, curbs, and the floor slabs of culverts and tunnels.

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 Removals - Partial Depth, Type A and Type B that 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 removal 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, and pier columns and 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 means two or more steel reinforcement bars placed in a plane parallel to a concrete face.

Mat means transverse and longitudinal layers of steel reinforcement tied together.

Rehabilitation means the modification, alteration, or improvement to a structure or its components that is designed to correct defects or deficiencies.

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.

Structure means a bridge, culvert, tunnel, retaining wall, wharf, dock, and 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 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 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 equipment 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.

928.04.02 Submission Requirements

928.04.02.01 General

All Working Drawings, removal methods, and calculations shall bear the seal and signature of an Engineer.

At least 2 weeks prior to commencement of the work, 5 copies of any proposal shall be submitted to the Contract Administrator.

When other authorities are involved in the approval of the design or construction of a highway structure, the submission shall be made at least 5 weeks prior to commencement of work. The submission shall include one additional set of the submission for each authority.

Work shall not commence until written notice to proceed has been given by the Contract Administrator.

928.04.02.02 Working Drawings and Concrete Removal Methods

At least 3 weeks prior to the start of the concrete removal, 3 sets of Working Drawings and the methods for concrete removal shall be submitted to the Contract Administrator.

Working Drawings and concrete removal methods shall contain the following information:

- a) Layout and description of:
 - i. Concrete removal sequences.
 - ii. Concrete removal equipment.
 - iii. Saw cutting details.
 - iv. Access to work areas, work platforms, and scaffolding.
 - v. Temporary supports.
 - vi. Debris platforms provided for the protection of pedestrians, traffic, and the environment.
- b) Identification of all components to remain in place and measures to be taken to ensure that they are not damaged during removal operations.
- c) Clearances at existing and proposed structures.
- d) A statement by the design Engineer certifying that, based on the existing drawings of the structure and the assumption that these drawings are a realistic representation of the existing structure, the proposed method and sequence of removals satisfies the structural adequacy, stability, integrity, and serviceability requirements of the structure according to CAN/CSA S6, including the following:
 - i. Existing structures supporting heavy equipment and vehicles.
 - ii. Lifting and handling of large pieces of concrete greater than 2 m in any dimension.
- e) Identification of the milestone inspections necessary for safe execution of concrete removal, such as the following:
 - i. Installation of temporary supports.
 - ii. Installation of temporary protection for pedestrians, traffic, and environment.
 - iii. Structural strengthening or modification.
 - iv. Removal of existing dead load or earth pressure, or both.

The Contractor shall have a copy of the stamped Working Drawings and removal methods on site at all times while the work is being carried out.

928.04.02.03 Return of Submissions

Two copies of each submission to be returned shall be marked as one of the following:

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

In this case, work can commence on receipt of the Working Drawings by the Contractor.

- b) Stamped with the wording that allows for permission to construct as noted.

In this case, work can start on receipt of the Working Drawings by the Contractor. The Working Drawings shall be updated as noted and shall have a stamp affixed that is signed by an Engineer stating that the Working Drawings have been revised according to the noted comments.

- c) Showing only required changes.

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

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, when applicable, and a maximum piston stroke of 102 mm.
- b) Jackhammers shall have a maximum weight of 14.0 kg.
- c) All air 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.

928.06.02 Rig-Mounted Breakers

Rig-mounted breakers using pneumatically driven equipment shall be fitted with amoil point only and produce a maximum energy of 1,000 Joules per blow, as identified on the unit by the manufacturer.

928.06.03 Sawing Equipment

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

Scarifying equipment shall be capable of removing a minimum of 6 mm of concrete from the 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, in lengths of 1.5 m and 3 m shall be available on site.

928.07 CONSTRUCTION

928.07.01 General

Concrete shall not be removed beyond the specified depth and demarcated boundaries for concrete removal unless approved by the Contract Administrator.

The depth of concrete removal shall be as specified.

The Contract Administrator shall be notified to inspect the removal areas upon completion of the concrete removal in the demarcated areas. Additional areas of concrete removals identified by the Contract Administrator shall be removed according to this specification.

928.07.02 Operational Constraints

928.07.02.01 General

Concrete shall not be removed within 1 m of newly placed concrete until the newly placed concrete has attained a compressive strength of at least 20 MPa.

Concrete shall be removed in such a manner as to prevent damage to the concrete to remain in place and debonding of steel reinforcement beyond the demarcated removal area. Steel reinforcement, 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, to ensure that concrete removals do not exceed the demarcated boundaries and depths specified for removals in the Contract Documents.

Only equipment specified herein 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 Remedial Work subsection.
- b) Vehicles, runways, and equipment other than hand held equipment shall not be supported by steel reinforcement.
- c) Heavy vehicles such as ready mix concrete trucks or dump trucks are not permitted on any portion of the deck within a span once concrete removals within the deck have commenced in that span.

All debris from the saw cutting operation shall be managed as specified in the Contract Documents.

928.07.02.02 Concrete Removal - Partial Depth, Types A, B, and C

Chipping hammers shall be used for all partial depth concrete removals.

928.07.02.03 Concrete Removal - Full Depth, Structural Component, Complete Deck, and Deck Joint Assemblies

928.07.02.03.01 Sawing Equipment

The use of sawing equipment, except for perimeter treatments of concrete removal areas, shall not be permitted for concrete removal as follows:

- a) Within the lap length of steel reinforcement 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 saw cuts in a concrete deck close to areas of existing structural steel members and other components that are to remain, the concrete surface shall be accurately delineated to locate the underlying edges and 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.

928.07.02.03.02 Chipping Hammers

Chipping hammers shall be permitted in all areas of concrete removal.

928.07.02.03.03 Jackhammers

Jackhammers shall not be used for concrete removal as follows:

- a) For partial depth removals.
- b) Within 100 mm from concrete to remain in place.
- c) Within 25 mm of any steel reinforcement to remain in place.
- d) Within 100 mm from the edges and faces of structural steel members to remain in place.

928.07.02.03.04 Rig-Mounted Breakers

Rig-mounted breakers shall not be used for concrete removal as follows:

- a) For barrier walls, parapet walls, and deck slabs supported by concrete girders, unless the girders are to be removed.
- b) For barrier walls 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 lap length of steel reinforcement to remain in place as specified in the Contract Documents.
- e) Within 600 mm from the edge and faces of structural steel members including shear studs to remain in place.

928.07.02.03.05 Concrete Crusher

Concrete crushers shall not be used for the removal of concrete as follows:

- a) Within 2 m of concrete to remain in place.
- b) Within 1 m of steel reinforcement to remain in place.
- c) Within 300 mm from the edge and faces of structural steel members, including shear studs to remain in place.

928.07.03 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.

928.07.04 Concrete Survey

928.07.04.01 General

The Contractor shall schedule the work to ensure there is no interference with the required concrete survey operations.

928.07.04.02 Covermeter Survey

The Contractor shall allow the Contract Administrator to carry out a bridge deck covermeter survey prior to the first pass of the scarifying equipment of any deck, when concrete removals from the top surface of the deck are specified in the Contract Documents.

When scarifying of the concrete surface is 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.

When the specified depth of scarifying is greater than 10 mm, the Contractor shall allow the Contract Administrator a period of at least two hours per 100 m² of the bridge deck surface to be scarified, or any part thereof to complete the covermeter survey, prior to commencing the subsequent pass of scarifying.

928.07.04.03 Concrete Removal Survey

928.07.04.03.01 General

The Contractor shall submit written notification to the Contract Administrator to carry out all applicable concrete removal surveys. The notification shall state that the Contractor has completed all applicable work requirements for the concrete removal surveys specified herein and has installed all accesses to the work area, including work platforms and scaffolding required by the Contract Administrator to carry out the surveys.

Immediately prior to the commencement of the concrete removal survey, all equipment, debris, and standing water shall be removed from the surfaces to be surveyed.

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 is to be carried out on the top surface of the entire overlay. The second survey is to be carried out on the top surface of the original deck, after the existing overlay has been removed, within the removal area.

- b) Corrosion Potential Survey (Half-Cell) - When specified in the Contract Documents a corrosion potential survey shall be carried out on all surfaces when concrete is to be removed based on corrosion potential criteria.

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 and reviewed and written permission to proceed has been given by the Contract Administrator.

928.07.04.03.02 Work Requirements

Prior to the concrete removal surveys, the Contractor shall carry out all applicable work, when all or some of the following are specified in the Contract Documents:

- 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 steel reinforcement is continuous. The steel reinforcement within these locations shall be exposed for a length of 150 mm and a clearance of 25 mm all around the bar.

928.07.04.03.03 Time Requirements

The time required by the Contract Administrator to complete the concrete removal survey, including review of the surveys by the Owner, shall be as shown in Table 1 and shall commence upon receipt of the Contractor's written notification to carry out the concrete removal survey. When the area of a structure exceeds the maximum area surveyed per time period shown in Table 1, the time period shall be extended on the basis of prorating the area, rounded up to the nearest Working 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.

928.07.05 Scarifying

928.07.05.01 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 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 depth specified in the Contract Documents shall be re-scarified using smaller scarifying equipment or chipping hammers, if necessary, until the required depth is achieved.

The portion of the curb face, barrier wall, or parapet wall that is to be covered by an overlay shall be roughened by scrubbling, chipping, or bush hammering. A surface profile of $5 \text{ mm} \pm 2 \text{ mm}$ 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.

928.07.05.02 Protection of Steel Reinforcement

The Contractor shall immediately notify the Contract Administrator of any exposed steel reinforcement on the concrete surface prior to and at any time during the scarifying operation. Operations shall be adjusted to avoid contacting the steel reinforcement with the scarifying equipment.

The Contract Administrator shall demarcate an area around all exposed steel reinforcement. The concrete shall be removed from within the demarcated area to the depth specified for the adjacent scarifying using chipping hammers or as directed by the Contract Administrator.

Exposed steel reinforcement shall not be cut or removed, unless otherwise directed in writing by the Contract Administrator.

928.07.06 Steel Reinforcement in Concrete Removal Areas

When specified in the Contract Documents, the cutting, bending, and removal of steel reinforcement shall be part of the concrete removals. Cutting and bending of steel reinforcement shall be according to OPSS 905.

When the area of concrete removal with exposed steel reinforcement exceeds 2 m^2 , the steel reinforcement 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 steel reinforcement according to OPSS 905.

928.07.07 Concrete Removals

928.07.07.01 Concrete Removal - Partial Depth, Types A, B, and C

928.07.07.01.01 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 saw cut.
- b) Shotcrete - Prior to carrying out concrete removal operations, the perimeter of the removal area shall be saw cut to a depth of 10 mm or to the depth of the steel reinforcement, whichever is less. The perimeter of the removal area shall have a face perpendicular to the original concrete surface of the removal area for the depth specified in the Contract Documents.

- c) Concrete Patches - Prior to carrying out concrete removal operations, the perimeter of the removal area shall be saw cut to a depth of 25 mm or to the depth of the steel reinforcement, whichever is less. The perimeter of the removal area shall have a face perpendicular to the original concrete surface of the removal area for the depth specified in the Contract Documents.

Saw cutting for perimeter treatment of concrete removal areas for cases b) and c) above is not permitted when the cut is located as follows:

- a) Within the lap length of steel reinforcement to remain in place.
- b) Within 100 mm from the edges and faces of structural steel members and concrete components to remain in place.

In these areas, chipping hammers shall be used.

928.07.07.01.02 Depth of Concrete Removal Areas

When existing overlays are 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.

In reinforced areas, concrete removal shall extend below the steel reinforcement 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 the corrosion potential of the steel reinforcement is more negative than minus 0.35 volts, as determined by the corrosion potential survey when specified in the Contract Documents.
- c) All areas of exposed steel reinforcement.

Concrete in these areas shall be removed to a uniform depth of 25 mm behind the first layer of steel reinforcement. Concrete surrounding the second layer of steel reinforcement shall also be removed locally to provide a minimum clearance of 25 mm all around the steel reinforcement. Concrete removal beyond the second layer of steel reinforcement shall be carried out only when directed by the Contract Administrator.

For all other concrete removals demarcated by the Contract Administrator, such as scaling, concrete shall be removed to either of the following:

- 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.

928.07.07.02 Concrete Removal for Full Depth

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 saw cut to a depth of 25 mm or to the depth of the steel reinforcement, 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 steel reinforcement, whichever is less. The concrete removals shall be completed from the soffit using chipping hammers.

Prior to carrying out any other concrete removals, the perimeter of the demarcated removal area shall be saw cut to a depth of 25 mm or to the depth of the steel reinforcement, whichever is less.

928.07.07.03 Concrete Removal for Structural Component and Complete Deck

Concrete deck or structural component removal shall be carried out according to the Contract Documents, the Working Drawings and this specification.

928.07.07.04 Concrete Removal for Deck Joint Assemblies

Existing deck joint assemblies, including joint filler materials and surrounding concrete, shall be removed according to the requirements of the Contract Documents and this specification.

928.07.08 Remedial Work

The Contract Administrator shall be notified immediately in writing if any of the following work related defects are present, including 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 steel reinforcement to remain as specified in the Contract Documents.
- c) Damage to structural steel and other components that are to remain in place.
- d) Contaminated concrete.

A proposal for the remedial work shall be submitted to the Contract Administrator for review. The Contractor shall not proceed with repairs until approval of the proposal has been received in writing from the Contract Administrator.

928.07.09 Management of Excess Material

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

928.08 QUALITY ASSURANCE

928.08.01 Acceptance or Rejection

When concrete removals are completed in areas designated for removal, the work shall require inspection by the Contract Administrator to determine if there are any additional removals within the demarcated areas and along the perimeter, to verify that the concrete has been removed to the depth and dimensions specified in the Contract Documents, and to identify any defects in the work. The Contract Administrator shall demarcate any additional areas of concrete removal.

Work related defects listed in the Remedial Work subsection shall be deemed unacceptable and shall be subject to remedial work.

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 scarified.

The total area shall be calculated to the nearest 0.1 m^2 .

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.

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 by area in square metres of concrete removed. The depth of removal shall be as specified in the Contract Drawings.

The total area shall be calculated to the nearest 0.1 m^2 .

928.09.01.02.03 By Volume

Measurement shall be by volume in cubic metres of concrete removed to the depth specified or to the depth approved by the Contract Administrator.

Material removed locally 25 mm around the second layer of steel reinforcement shall not be measured. However, if the Contract Documents specify a uniform removal below the second layer of reinforcing steel, measurement for payment shall be of the volume of concrete removed to the specified depth.

After concrete removal is completed, verification of concrete removal depths shall be completed by the Contract Administrator on a grid system that best describes the profile at the particular area.

Measurement shall be taken by placing a straight edge across the removal area and measuring the distance from the straight edge to the top of the remaining concrete surface, as follows:

- a) A minimum of three measurements for each removal area less than or equal to 1.0 m^2 .
- b) A minimum of ten measurements for every square metre for each removal area greater than 1.0 m^2 .

The depths for each removal area shall be measured and averaged to the nearest millimetre.

The total volume shall be calculated to the nearest 0.1 m^3 .

928.09.01.03 Concrete Removal - Full Depth

Measurement shall be by volume in cubic metres of concrete removed. Alternatively, full depth concrete removal may be a lump sum item.

The total volume shall be calculated to the nearest 0.1 m^3 .

928.10 BASIS OF PAYMENT

928.10.01 Scarifying - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

When exposed steel reinforcement 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 - Partial Depth, Type A - Item
Concrete Removal - Partial Depth, Type B - Item
Concrete Removal - Partial Depth, Type C - Item
Concrete Removal - Full Depth - Item
Concrete Removal - Structural Component - Item
Concrete Removal - Complete Deck - Item
Concrete Removal - Deck Joint Assemblies - 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 item shall include full compensation for all labour, Equipment, and Material to provide access to the work area, work platform, and scaffolding.

Payment for the appropriate tender item Concrete Removal - Partial Depth Type A, Concrete Removal - Partial Depth Type B, 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 steel reinforcement is required, payment for this work shall be made according to the Extra Work provisions in the Contract Documents.

Costs associated with the work required to repair defects shall be the Contractor's responsibility at no extra cost to the Owner.

Payment shall not be made of the roughened portions of curb faces and barrier walls or of areas that require a second scarifying due to the Contractor's method of operation.

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

The designer should determine if any of the following are required and, if so, specify them in the Contract Documents.

- Debris platforms. (928.04.02.02)
- Saw cutting lines and depths. (928.06.03)
- Depth and areas for concrete removal (928.07.01)
- Management requirements for debris from saw cutting operations. (928.07.02.01)
- Scarifying depths and areas. (928.07.05.01)
- Corrosion potential survey. (928.07.04.03.01)
- Lap length of steel reinforcement to remain in place. (928.07.02.03.01)
- Cutting, bending, and removal of steel reinforcement. (928.07.05)
- Overlay or refacing areas. (928.07.07.01.02)
- Concrete deck or structural component removal. (928.07.07.03)
- Concrete removal at deck joint assemblies. (928.07.07.04)
- Measurement method for Concrete Removal - Partial Depth, Types A, B, and C

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR STRUCTURE REHABILITATION - CONCRETE PATCHES AND OVERLAYS

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APPENDICES

915-A	Commentary

930.01	SCOPE

This specification covers the requirements for the surface preparation, and the placing, finishing, texturing, and curing of concrete and latex modified concrete used in structure rehabilitation.

930.01.01 Specification Significance and Use

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

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

930.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

930.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 904	Concrete Structures
OPSS 905	Steel Reinforcement for Concrete
OPSS 919	Formwork and Falsework
OPSS 928	Structure Rehabilitation - Concrete Removal
OPSS 929	Abrasive Blast Cleaning - Concrete Construction

Ontario Provincial Standard Specifications, Material

OPSS 1002	Aggregates - Concrete
OPSS 1301	Cementing Materials
OPSS 1302	Water
OPSS 1305	Moisture Vapour Barrier
OPSS 1306	Burlap
OPSS 1312	Latex Modifiers for Use in Concrete
OPSS 1350	Concrete - Materials and Production

CSA Standards

C22.2 No. 211.2-M1984	Rigid PVC - Unplasticized Conduit
G 30.5-M 1983	Welded Steel Wire Fabric for Concrete Reinforcement
CAN/CSA G 164-M92	Hot Dip Galvanizing for Irregularly Shaped Articles

ASTM International

A 53-90b Pipe, Steel, Black and Hot Dipped, Zinc Coated, Welded and Seamless
D 4285-83-1988 Method for Indicating Oil or Water in Compressed Air

Ontario Ministry of Transportation Publications

MTO Laboratory Testing Manual:

LS601-89 Materials Finer Than 75 µm Sieve in Mineral Aggregates by Washing
LS607-89 Determination of Percent Crushed Particles in Processed Coarse Aggregate

930.03 DEFINITIONS

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

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

Hardwood means wood with a degree of hardness equal to species such as hard maple, oak, or beech.

Layer - Reinforcing Steel means two or more reinforcing bars placed in a plane parallel to a concrete face.

Mat - Reinforcing Steel means transverse and longitudinal layers of reinforcing steel tied together.

Rehabilitation means any modification, alteration, or improvement to a structure or its components that is designed to correct defects or deficiencies.

Structure means any bridge, culvert, tunnel, retaining wall, wharf, dock, guideway, or any part thereof.

Proposal means a Contractor's submission of changes when engineering design is required affecting the original design as stipulated in this specification.

930.04 DESIGN AND SUBMISSION REQUIREMENTS

930.04.01 Design Requirements

930.04.01.01 Proposals

930.04.01.01.01 General

Proposals by the Contractor shall bear the seal and signature of an Engineer.

Three sets of the proposal shall be submitted to the Owner 3 weeks prior to commencement of the work.

930.04.01.02 Screed Rails

An alternative screed rail system to that specified in the Finishing Equipment - Overlays clause may be used. At least 4 weeks prior to the commencement of placing screed rails, 3 complete sets of Working Drawings detailing the proposal shall be submitted to the Contract Administrator. These drawings shall include: type, dimensions of the rails to be used, spacing of screed rail chairs, details of the finishing machine, and the calculations showing the design deflection in the system. One set of these drawings shall be returned marked to indicate required changes. Eight sets of these drawings revised where necessary shall be resubmitted.

When all Owner requirements are satisfied, 2 sets of the Working Drawings shall be returned.

930.04.02 Submission Requirements

930.04.02.01 Cement Certification

Prior to using the cement in the latex modified concrete mix, one copy of the cement supplier's certificate stating that the cement is certified free from early stiffening tendencies shall be submitted to the Contract Administrator.

930.04.02.02 Mix Design

930.04.02.02.01 Concrete and Latex Modified Mortar Mix

The Contractor shall be responsible for designing the mix.

930.04.02.02.02 Latex Modified Concrete

The Contractor shall only design the mix when specified in the Contract Documents.

930.04.02.02.03 Concrete, Latex Modified Concrete, and Latex Modified Mortar Mix

When the Contractor designs the mix, the Contractor shall submit the mix proportions to the Contract Administrator at least 3 weeks prior to production of the concrete.

930.04.02.03 Certificate of Calibration for the Latex Modified Concrete Mixing Plants

A certificate of calibration shall be provided to the Contract Administrator for each of the following:

- a) Cement feed meter indicating the cement meter register count and discharge time for 42.64 kg of cement for each mixing unit. The method of test shall be according to the field calibration of cement feed meter specified in the equipment manufacturer's instructions. The minimum quantity of cement for each test run shall be 50 kg.
- b) Latex rate of flow and totalizer meters. The meters shall be calibrated according to the tolerances specified in the Latex Modified Concrete Mixing Plant clause. A minimum quantity of 1,000 litres of latex shall be discharged during the calibration of the meters.
- c) The water totalizer meter shall be calibrated according to the tolerances specified in the Latex Modified Concrete Mixing Plant clause or a minimum quantity of 1,000 litres.

Each certificate shall be signed by an independent testing agency and shall be dated within 90 Days prior to each use of the specific mixing unit on the Contract. Aggregate gate openings and pointer adjustments, as well as the general operating condition of equipment shall also be checked by the independent testing agency according to the manufacturer's instructions.

The Contract Administrator may require recalibration of the cement feed meter.

930.04.02.04 Certification of Superplasticizer

Prior to using the superplasticizer, one copy of a certificate from the superplasticizer manufacturer stating that the superplasticizer is certified compatible with the cementitious materials and admixtures being used shall be submitted to the Contract Administrator.

930.05 MATERIALS

930.05.01 Cement

The cement shall be according to OPSS 1301.

930.05.02 Concrete and Latex Modified Concrete

930.05.02.01 General

The concrete shall be according to OPSS 1350 and as shown in Table 1.

930.05.02.02 Aggregates

930.05.02.02.01 General

Aggregates including sand for the bonding agents shall be according to OPSS 1002 and the requirements specified herein.

930.05.02.02.02 Aggregates for Overlays

Coarse aggregate shall consist of a minimum of 60% crushed particles when tested according to LS-607. Except for latex modified concrete, aggregates shall have 1.00% by mass maximum passing the 75 µm sieve when tested according to LS-601.

Coarse aggregate for overlays that form the bridge deck riding surface shall be composed of at least 80% siliceous igneous and metamorphic rocks and minerals.

930.05.02.02.03 Aggregates for Latex Modified Concrete Overlays

Aggregates shall have 0.50% by mass maximum passing the 75 µm sieve when tested according to LS-601. All aggregates, estimated quantities required for completion of each stage of the latex modified concrete overlays, shall be stockpiled within the Contract limits or at a site approved by the Contract Administrator at least 3 weeks prior to placing the overlay in that particular stage. The fine aggregate stockpile shall be covered to prevent variation of moisture content in the pile.

When additional aggregate is required, the material shall be similar and come from the same source.

930.05.03 Latex Modifier

The latex modifier shall be according to OPSS 1312 and shall be delivered to the job site in sealed containers with the trade name and date of manufacture affixed to the containers by the manufacturer.

The latex modifier shall be maintained above 5 °C and below 30 °C at all times. Sufficient latex modifier to complete the work shall be delivered to the job site prior to the commencement of the testing of the continuous concrete mixing plant and at least 7 days prior to commencement of the work in which the latex modifier shall be used.

The latex modifier shall be agitated immediately prior to use according to the manufacturer's instructions.

930.05.04 Burlap

Burlap shall be according to OPSS 1306.

930.05.05 Water

Water shall be according to OPSS 1302.

930.05.06 Bonding Agents

930.05.06.01 Cement-Sand

Cement-sand bonding agent shall consist of Portland cement and sand in the ratio of 1:1 by volume mixed with sufficient water to form a stiff mixture. The consistency of the mixture shall be such that it can be applied with a stiff brush to the existing concrete in a thin even coating that shall not run or puddle.

930.05.06.02 Latex Modified

Latex modified bonding agent shall consist of Portland cement, latex modifier, and sand in the ratio of 1.0:0.5:2.0 by volume mixed with sufficient water to produce a consistency such that when applied with a stiff brush to the existing concrete in a thin even coating it shall not run or puddle.

930.05.07 Welded Steel Wire Fabric

The welded steel wire fabric shall be welded galvanized steel and shall be according to CSA G 30.5. Galvanizing shall be according to CAN/CSA G164.

930.05.08 Anchorage Inserts

Anchorage inserts for the attachment of the welded steel wire fabric to the concrete surface shall be galvanized according to CAN/CSA G 164 and be of adequate length and strength to resist a pull-out force of 1.0 kN.

930.05.09 Tie Wire

Tie wire shall be according to OPSS 905.

930.05.10 Moisture Vapour Barrier

The moisture vapour barrier shall be polyethylene film, opaque, white pigmented, according to OPSS 1305, and shall not be less than 100 µm thick.

930.05.11 Drainage Tubes

Rigid PVC drainage tubes shall be according to CSA C22.2 No. 211.2. Galvanized steel drainage tubes shall be according to ASTM A53. Galvanizing shall be according to CSA G.164.

930.05.12 Latex Modified Mortar Mix

The Portland cement and fine aggregate, dry basis, proportions of the mix shall be designated by mass. The latex modifier to cement ratio by mass shall be one part latex modifier to three parts cement.

The water to cement ratio, by mass, shall not be greater than 0.35 which shall include the water in the latex modifier and in the fine aggregate. The latex modifier shall not be diluted. Fine aggregates shall be according to OPSS 1002 and shall contain not less than 3% and not more than 5% moisture by mass.

930.05.13 Superplasticizer

Superplasticizer shall be according to OPSS 1350.

930.06 EQUIPMENT

930.06.01 Mixers

930.06.01.01 General

The equipment used for mixing concrete shall be according to OPSS 1350, except as specified herein for latex modified concrete mixing plant and stationary mixers.

930.06.01.02 Latex Modified Concrete Mixing Plant

Mobile continuous concrete mixing plant shall be used for latex modified concrete and shall not be less than 5 m³ capacity and shall be equipped with:

- a) A storage tank for the latex modifier equipped with a mechanical agitator.
- b) Two meters to measure the discharge of latex modifier; one shall record the rate of flow to an accuracy of ± 0.5 litre per minute and the other shall record the total volume discharged to an accuracy of $\pm 1.5\%$.
- c) A meter that records the total quantity of water used in the concrete to an accuracy of $\pm 1.5\%$.
- d) A meter, visible at all times with a ticket printout and capable of positive measurement of cement being introduced into the mix.
- e) A positive control for the flow of water being introduced into the mix, coordinated with the cement and aggregate feeder mechanisms, and adjustable for minor variations in aggregate moisture.

930.06.01.03 Stationary Mixers

Stationary mixers for the mixing of cement-sand and latex modified bonding agents shall be power driven and capable of uniformly mixing the materials.

930.06.02 Compressor - Air Blasting

The compressor for air blasting shall have a minimum capacity of 3.5 m³/minute. The compressed air shall be free from oil when tested according to ASTM D4285.

930.06.03 Sawing Equipment - Overlays

The sawing equipment shall be self-propelled and capable of sawing the overlay concrete full depth in one pass.

930.06.04 Work Bridges

A work bridge, riding on the screed rails behind the finishing machine with a working platform not higher than 1.5 m above the finished surface shall be provided to facilitate hand finishing work, concrete inspection, texturing, and placing of curing material. On placements longer than 40 m or wider than 10 m, a second work bridge shall be provided. When two work bridges are required, the trailing work bridge shall ride on the screed rails and shall be used for the purpose of placing the curing material and shall have sufficient clearance to allow for their proper placement.

930.06.05 Straight Edge

The straight edge shall be 3 m long and commercially made of metal.

930.06.06 Finishing Equipment - Overlays

930.06.06.01 Finishing Machine

The finishing machine shall be self-propelled, and travel on rails. It shall be fitted with a rotating cylinder screed, capable of finishing the surface without subsequent hand finishing, an adjustable powered screw auger and a vibrator plate or roller mounted in front of the rotating cylinder screed and behind the power screw auger. It shall be capable of forward and reverse movement under positive control. There shall be provision for raising all screeds to clear the screeded surface and for accurately repositioning the screeds. It shall have adjustable legs fitted with locking devices.

930.06.06.02 Screed Rails

The screed rails shall be straight to within 3 mm in 3 m. The maximum deflection of the screed rails under load shall be 1 mm in a 1.2 m length.

930.06.06.03 Screed Rail Chairs

Screed rail chairs shall be adjustable in height and made of metal. At locations where metal chairs cannot be accommodated, hardwood may be used to support the rail.

930.06.07 Buggies

Buggies used for transporting and placing the concrete may be hand operated or motorized. Motorized concrete buggies shall not be greater than 0.5 m³ capacity.

930.06.08 Scales

The scales used for the calibration of the mobile continuous concrete mixing plant shall have a minimum capacity of 200 kg with an accuracy of ± 1 kg in 200 kg. Proof of the accuracy of the scales is required prior to each calibration.

930.06.09 Consolidating Equipment

Consolidating equipment shall be according to OPSS 904.

930.06.10 Hand Finishing Equipment

Only magnesium or wood floats shall be used. Bull floats shall be magnesium.

930.07 CONSTRUCTION

930.07.01 Modification of Deck Drains

Modification of deck drains shall be made prior to waterproofing the deck.

930.07.02 Drainage Tubes in Deck

Installation of drainage tubes shall be done prior to waterproofing the deck.

**930.07.03 Place Concrete Overlay
Place Latex Modified Concrete Overlay**

930.07.03.01 Operational Constraints

The Contract Administrator shall be notified of the intent to place the overlay 1 Business Day prior to the commencement of the placement of the overlay. The work shall not proceed until the surface preparation has been inspected by the Contract Administrator.

Only the finishing machine and buggies used to place concrete shall be allowed on the abrasive blast cleaned portion of the deck.

Areas of reinforcing steel and concrete prepared for concrete overlay shall be protected at all times during placing operations from the dropping of the bonding agent or concrete from placing equipment or other sources, except at the intended point of discharge. Any such material shall be immediately removed.

Equipment transporting concrete and runways used by equipment transporting concrete shall not be supported by deck reinforcing steel.

Placement of concrete shall not begin until the trial run procedure as specified is complete and permission to place concrete has been given in writing by the Contract Administrator. In the case of unexpected interruptions during placing operations, a construction joint shall be formed by either chopping or sawcutting at the direction of the Contract Administrator and all new concrete shall be covered with polyethylene film. Portions of the concrete overlay with incomplete or unsatisfactory consolidation or finishing shall be removed.

Overlay concrete shall not be placed when the air or deck temperature is below 10 °C or likely to fall below 10 °C or is above 30 °C or likely to rise above 30 °C during the duration of the placing operations.

Longitudinal construction joints shall be permitted only where specified in the Contract Documents.

Concrete shall not be placed adjacent to longitudinal joints in concrete overlay less than 36 hours old. At temperatures less than 10 °C, the Contract Administrator may extend this time requirement.

Neither construction traffic nor highway traffic shall be permitted on the finished surface of the overlay concrete until the curing period has elapsed.

Prior to seasonal shutdown, operations shall be scheduled in such a manner to ensure that the overlay is placed in all areas where concrete removal has commenced.

930.07.03.02 Minimum Thickness of Overlay

The minimum thickness of the overlay shall be 35 mm for the latex modified concrete overlay and 45 mm for the concrete overlay.

930.07.03.03 Surface Preparation

When anode mesh is not used, immediately prior to wetting the deck surface, all dust and loose material shall be removed from the prepared surface of the existing deck concrete by compressed air.

When anode mesh is used, within 4 hours prior to application of the overlay the concrete surface, with anode mesh in place shall be pressure washed with water using a pressure not less than 1.4 MPa to remove debris resulting from drilling of anchor holes and other accumulated dirt adhering to the anode or concrete surfaces.

The deck surface shall be maintained in a wet condition for a period of one hour prior to the application of the bonding agent. Excess water shall be removed from the surface using compressed air, immediately prior to application of the bonding agent.

930.07.03.04 Longitudinal Construction Joints

Lumber with a thickness of 10 to 15 mm less than the nominal thickness of the overlay shall be affixed to the deck to permit the concrete to spread no less than 75 mm and no more than 125 mm beyond the construction joint.

Polyethylene, asphalt, saturated felt, or other suitable debonding material shall be secured beneath the lumber and extended to within 25 mm of the sawcut line.

930.07.03.05 Placing of Screed Rails

Screed rails for the finishing machine shall be supported on screed rail supports at intervals not to exceed 1.0 m.

Supports for the screed rails shall be placed outside the finished concrete, where possible.

The screed rails shall be continued beyond the deck at each end to a length that will enable the finishing machine to be driven beyond the end of deck.

930.07.03.06 Trial Run

A trial run shall be made prior to each placing operation to ensure that the minimum thickness of the overlay is achieved. Where the trial run indicates that an unsatisfactory thickness will result, the screed rails shall be adjusted in order to obtain the minimum thickness and the trial run repeated in the area of screed rail adjustment.

930.07.03.07 Placing

A thin coating of the bonding agent, cement-sand for concrete and latex modified bonding agent for latex modified concrete shall be brushed into the prepared surface. All vertical and horizontal surfaces against which the overlay will be placed shall receive a thorough even coating with no excess of bonding agent in any areas. Excess fine aggregate separated from the bonding agent mixture after application shall be removed from the deck surface. The rate of application of the bonding agent shall be such that the brushed material does not become dry prior to being covered with overlay. At no time shall the bonding agent be placed more than 2 m in front of the overlay placement. Bonding agent not used within 30 minutes after mixing shall not be used.

The overlay shall be placed on the deck and struck off slightly above final grade using concrete rakes.

In the event of an interruption in the placing of the overlay, the exposed edge of the overlay shall be covered immediately with wet burlap. If the delay in placing exceeds 10 minutes, the bonding agent already applied to the deck shall be removed.

When undue delays occur, all overlay material ahead of the deck finishing machine shall be removed and a joint formed.

The overall combination of labour and equipment for proportioning, mixing, placing and finishing the overlay shall be capable of finishing a minimum of 4 m³ of overlay per hour and shall be arranged that not more than 20 minutes elapses between discharge of the overlay from the mixer and the final finishing.

930.07.03.08 Remedial Work

Debonded and honeycombed areas shall be removed and replaced. Cracks shall be treated according to the requirements shown in Table 2.

930.07.04 Finish and Cure Concrete Overlay Finish and Cure Latex Modified Concrete Overlay

930.07.04.01 Surface Finish

The overlay shall be mechanically consolidated by the finishing machine and struck off to the final grade. The surface finish shall be free from open tears, plucked aggregates, and local projections. Areas adjacent to the curb that cannot be machine finished and areas not meeting the surface finish requirements shall be finished with hand finishing equipment.

The use of water or other material to aid in finishing shall not be permitted.

The inability to produce a uniform closed surface to the overlay shall be cause for rejection of the overlay in the affected area. Overlay rejected shall be removed and new overlay placed using methods approved by the Contract Administrator.

930.07.04.02 Surface Tolerance

Except across the crown, the surface of the overlay after finishing and prior to any required texturing shall be such that when tested with a 3 m long straight edge placed anywhere in any direction on the surface there shall be no gap greater than 6 mm between the bottom of the straight edge and the surface of the concrete. Where the gap exceeds 6 mm, the overlay shall be either removed and new overlay placed or the overlay shall be refinished so that the requirement for surface tolerance is satisfied.

930.07.04.03 Surface Texture

Where the surface of the overlay forms the wearing surface of the bridge deck, the following surface texturing shall be carried out.

When a tight uniform surface has been achieved, the surface shall be given a texture with a wire broom or comb having a single row of tines. The required texture shall be transverse grooves that may vary from 1.5 mm width at 15 mm centres to 4.5 mm width at 20 mm centres with a groove depth varying from 3.0 to 4.5 mm. The texture shall extend uniformly to within 300 mm of the curb, but no closer than 150 mm.

930.07.04.04**Cure Concrete Overlay**

Two layers of wet burlap that have been presoaked by immersion in water for a period of 24 hour immediately prior to placement shall be placed on the concrete overlay within 2 to 4 m from the finishing operation. Strips shall overlap 150 mm and shall be held down without marring the surface of the concrete. The burlap shall be covered with a layer of moisture vapour barrier as soon as the moisture vapour barrier can be applied without deforming the surface of the concrete. The moisture vapour barrier shall be lapped a minimum of 150 mm. Air flow in the space between the moisture vapour barrier and the burlap shall be prevented by holding the moisture vapour barrier down at the edges and all laps. The burlap shall be kept continuously wet during the curing period.

Except as specified in the Sawcutting Construction Joints in Overlays clause, labour and Equipment shall not be allowed on the overlay for 12 hours after placement. The surface shall receive a wet burlap cure for not less than 96 hours. The curing material shall then be removed and the overlay permitted to air dry for not less than 72 hours prior to any application of waterproofing.

930.07.04.05**Curing Latex Modified Concrete Overlay**

One layer of wet burlap that has been presoaked by immersion in water for a period of 24 hours immediately prior to placement shall be placed on the surface of the concrete overlay within 2 to 4 m from the finishing operation. Strips shall overlap 150 mm and shall be held down without marring the surface of the concrete. The burlap shall be covered with a layer of moisture vapour barrier as soon as the moisture vapour barrier can be applied and held in place without deforming the surface of concrete. The moisture vapour barrier shall be lapped a minimum of 150 mm. Air flow in the space between the moisture vapour barrier and the burlap shall be prevented by holding the moisture vapour barrier down at the edges and all laps.

Except as specified in the Sawcutting Construction Joints in Overlays clause, labour and Equipment shall not be allowed on the overlay for 12 hours after placement. The surface shall receive a wet burlap cure for not less than 24 hours. The curing material shall then be removed and the overlay permitted to air dry for not less than 72 hours prior to any application of waterproofing. At temperatures less than 10 °C, the Contract Administrator may extend the curing period.

930.07.04.06**Sawcutting Construction Joints in Overlays**

As soon as the overlay is able to withstand the weight of the sawcutting equipment without damage and the overlay has sufficient strength to be sawcut without plucking of the aggregate, all free edges shall be sawcut for the full depth of the overlay. A minimum width of 75 mm of overlay shall be removed at each sawcut.

Excess overlay shall be removed using hand tools or chipping hammers. Burlap may be rolled back in areas where excess overlay has to be removed. The overlay shall not be exposed longer than 1 hour.

930.07.04.07**Testing of Continuous Concrete Mixing Plant for Latex Modified Concrete Overlay****930.07.04.07.01****Aggregate Discharge Test**

An aggregate discharge test shall be conducted on each mixing unit in the presence of the Contract Administrator. The mixing unit shall be available for this work for 1 Day prior to the first concrete placing operation. A test shall be conducted prior to the first placement of overlay and whenever the aggregate sources are changed or the mixer recalibrated.

930.07.04.07.02 Test for Flow Rate of Latex Modifier

The flow rate of latex modifier shall be determined by the Contractor. The test shall be conducted immediately prior to each placement of overlay and at other times as directed by the Contract Administrator. The tests shall be done in the presence of the Contract Administrator as follows:

- a) The flow meter for the latex modifier shall be adjusted to produce a flow rate of 122 ± 3 kg of latex per cubic metre of concrete. The latex modifier shall be discharged over a period of two minutes into a container that is free from contaminants and provided by the Contractor solely for this purpose. The container shall be weighed on approved scales. The weight of the container shall then be deducted from this figure. The procedure shall be repeated and the flow rate of the latex modifier calculated as the average of the two tests.
- b) The flow procedure shall be repeated, as necessary, until the flow rate is adjusted to yield the prescribed quantity of latex modifier.

930.07.04.07.03 Yield Test

A yield test shall be carried out immediately prior to each placement of overlay and at other times, as directed by the Contract Administrator. The yield test shall be carried out by the Contractor in the presence of the Contract Administrator after the mixing units have been loaded with the required aggregates, cement, water, and admixtures or latex modifier. With the cement meter set at zero, the mixer portion of the unit set at an angle of 20 degrees and all controls set for the desired mix, concrete with the specified air content and slump shall be discharged into a 0.2 m^3 container provided by the Contractor. When the container is full, the cement meter shall display a value indicating a discharge of 78 kg of cement.

Where the specified yield is not produced, adjustments shall be made in the aggregate proportions and the test repeated until such time as the yield is within 1.0% of the required yield.

930.07.05 Concrete Patches - Formed Surface Concrete Patches - Unformed Surface Latex Modified Mortar Patches Concrete Refacing

930.07.06.01 General

Typical locations and areas of repair are as specified in the Contract Drawings; however, the actual locations and extent of repair shall be as determined during the layout of the repair area according to OPSS 928.

930.07.06.02 Operational Constraints

The Contract Administrator shall be notified of the intent to place patching material or refacing materials or both 1 Business Day prior to commencement of placing the patching material or refacing materials or both. The work shall not proceed until the surface preparation has been inspected by the Contract Administrator.

Concrete patching shall not be carried out when the air or existing concrete surface temperature is below 10°C or likely to fall below 10°C , or is above 30°C or likely to rise above 30°C during the placing operation.

Patching operations shall be suspended during rain which, in the opinion of the Contract Administrator, may adversely affect the quality of the work, and portions of the concrete patch with incomplete consolidation or finishing shall be removed.

Construction equipment shall be permitted on the bridge deck and other concrete components subject to the following conditions:

- a) Contamination by oil or other deleterious substances shall be prevented.
- b) Equipment transporting concrete and runways used by equipment transporting concrete shall not be supported by deck reinforcing steel.
- c) Concrete mixing equipment and trucks shall not be placed on or travel over abrasive blast cleaned areas of concrete.

Patching operations shall be scheduled in such a manner to ensure that patching is completed in all areas where concrete removal has commenced, prior to seasonal shutdown.

930.07.06.03 Access to Work Areas, Work Platform and Scaffolding

Adequate access shall be provided to facilitate placement of the patch material, inspection, and measurement by the Contract Administrator.

930.07.06.04 Surface Preparation

Where the new concrete or mortar is to extend over the existing concrete surface, that portion of existing surface shall be roughened by scabbling, chipping or bush hammering. The concrete surfaces receiving new concrete or mortar shall be abrasive blast cleaned to an extent according to OPSS 929.

Abrasive blast cleaned areas shall have the subsequent treatment applied within 36 hours of patching or refacing or shall be reblasted.

All dust and loose material shall be removed from the prepared surface of the repair area by compressed air prior to the application of the bonding agent.

930.07.06.05 Placement of Welded Steel Wire Fabric

When welded wire fabric is required, it shall not be placed until after blast cleaning the existing concrete surface.

The edges of adjoining welded steel wire fabric shall be overlapped by two wire spacings plus 100 mm. The wires shall be kept clean of any substance which may reduce the bond of the repair material to the wire surface.

The welded steel wire fabric shall be securely fastened to the exposed reinforcing steel by ties placed at not more than a 300 mm square grid.

When the exposed reinforcing steel is not capable of providing rigid support for the wire fabric, anchorage inserts shall be used.

Where there is no existing reinforcing steel, the wire fabric shall be fastened to the concrete with anchorage inserts placed at not more than a 300 mm square grid and the minimum clearance between the wire fabric and the existing concrete shall be 20 mm.

Each anchorage insert shall be installed to resist a pull out force of at least 1.0 kN.

930.07.06.06 Formwork and Falsework

The erection and removal of formwork and falsework shall be according to OPSS 919 and shall be placed to provide the specified cover to reinforcing steel or wire mesh or both as specified in the Contract Documents. When this results in over building of the existing concrete surface, a 1H:1V slope shall be provided to meet the existing surface at the edge of the repair area.

930.07.06.07 Concrete Patches - Formed Surface Concrete Patches - Unformed Surface Concrete Refacing

930.07.06.07.01 Superplasticizer

Superplasticizer shall only be used when specified in the Contract Documents or approved by the Contract Administrator. When used, it shall be added according to OPSS 1350. The slump of the concrete shall be increased to 150 ± 30 mm by the addition of the superplasticizer. The superplasticizer shall be added to the concrete on the job site and in strict conformance with the manufacturer's written instructions. The concrete shall be tested for air content after the addition of superplasticizer.

930.07.06.07.02 Construction Joints

Construction joints in concrete shall only be permitted at the locations specified on the Contract Drawings and shall be according to the placing requirements of OPSS 904.

Prior to the placement of concrete, the concrete surfaces to be patched shall be maintained in a wet condition for a period of not less than one hour. Excess water shall be removed from the surface using compressed air immediately prior to application of the bonding agent and the surface shall be coated with a thin brush coating of the cement-sand bonding agent with no excess in any area. The rate of application of the bonding agent shall be such that the brushed material does not become dry prior to being covered with the patching material.

Where the concrete surface to be repaired is inaccessible for the application of bonding agent due to formwork the area to be repaired shall be maintained in a wet condition for a period of one hour and air blasted to remove excess water immediately prior to the placing of concrete.

The placement of concrete shall be according to the construction requirements of OPSS 904.

930.07.06.07.04 Surface Finish

The surface finish of formed surfaces and unformed surfaces shall be according to the construction requirements of OPSS 904.

930.07.06.07.05 Curing Concrete - Unformed Surfaces

Two layers of wet burlap shall be placed on the surface of the concrete as soon as the surface will support it without deformation. Burlap shall be presoaked by immersion in water for a period of 24 hours prior to placing. A layer of moisture vapour barrier shall be placed immediately on the wet burlap.

The concrete shall be cured using the wet burlap covered with moisture vapour barrier for a minimum period of 96 hours. The curing material shall then be removed and the concrete permitted to air dry for not less than 72 hours prior to any application of waterproofing.

Traffic shall not be permitted on the finished surface until the curing period has elapsed.

930.07.06.07.06 Curing Concrete - Formed Surfaces

Curing shall be according to the following:

- a) If the formwork is left in place for 96 hours or more, no additional curing shall be required.
- b) Where the formwork is removed in less than 96 hours, the concrete shall be cured as specified for unformed surfaces for the remainder of the 96 hour curing period.

930.07.06.08 Latex Modified Mortar Patches

930.07.06.08.01 Placing

Prior to the placement of the mortar, the area to be patched shall be maintained in a wet condition for a period of one hour. Excess water shall be removed from the surface using compressed air immediately prior to the placement of the bonding agent. The surface shall be coated with a thin brush coating of the latex modified bonding agent with no excess in any area. The rate of application of the bonding agent shall be such that the brushed material does not become dry prior to being covered with the mortar. The mixing of the latex modified mortar shall be carried out using mechanical mixers. The latex modified mortar for patching not used within 30 minutes after mixing shall not be used. The latex modified mortar shall not be retempered. The mortar shall be placed and consolidated in the repair area and screeded to the desired level. The surface shall be finished to a smooth and level surface immediately after placement.

The surface shall be closed with no tears or cracks. The inability to produce a uniform closed surface to the patch shall be cause for rejection of the latex modified mortar in the affected area.

930.07.06.08.02 Curing

Latex modified mortar shall be cured according to the requirements of the Curing Latex Modified Concrete Overlay clause. Neither construction traffic nor highway traffic shall be permitted over the patch until the curing period has elapsed.

930.07.07 Remedial Work

Debonded and honeycombed areas shall be removed and replaced. Cracks shall be treated according to the requirements as shown in Table 2.

The method of removal and repair shall be submitted to the Contract Administrator prior to commencement of the work.

930.07.08 Management of Excess Material

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

930.08 QUALITY ASSURANCE

930.08.01 Concrete and Latex Modified Concrete Overlays Concrete Patches Latex Modified Mortar Patches Concrete Refacing

930.08.01.01 Testing

930.08.01.01.01 Sampling, Delivery and Testing of Specimens

Sampling, delivery, and testing of specimens shall be according to OPSS 904. Samples and tests for slump and air content of the concrete shall be made as specified in the Contract Documents.

930.08.01.02 Inspection After Curing

The Contract Administrator shall inspect the work to determine if the completed work contains:

- a) areas of debonding.
- b) honeycombed areas.
- c) cracks.

930.08.02 Testing of Continuous Concrete Mixing Plant for Latex Modified Concrete Overlay

930.08.02.01 General

Tests shall be conducted according to the requirements for testing specified in the Testing of Continuous Concrete Mixing Plant for Latex Modified Concrete Overlay clause of the Construction section.

930.08.02.02 Latex Modifier

Tests shall be performed on the latex modifier.

930.09 MEASUREMENT FOR PAYMENT

930.09.01 Overlays - General

For all types of overlays there shall be no measurement for the following:

- a) Concrete discharged prior to the yield test.
- b) Concrete produced in excess of that required for the placing operation.
- c) Concrete placed on the deck more than 125 mm from the finished edge, after sawcutting of the overlay.
- d) Quantity of bonding agent.

930.09.02 Actual Measurement

930.09.02.01 Modification of Deck Drains

For measurement purposes, a count shall be made of the number of deck drains modified.

930.09.02.02 Drainage Tubes in Deck

For measurement purposes, a count shall be made of the number of drainage tubes placed.

930.09.02.03 Place Concrete Overlay

Measurement shall be of the volume of concrete placed in cubic metres by delivery ticket. When their quantities are included on the delivery ticket, deductions shall be made for concrete produced in excess of that required for the placing operation and for that concrete placed on the deck more than 125 mm from the finished edge after sawcutting of the overlay. The total volume shall be calculated to the nearest cubic metre.

930.09.02.04 Place Latex Modified Concrete Overlay

Measurement shall be by volume in cubic metres and shall be calculated from the mixing unit meter register ticket and calibration certificate. A copy of the meter register ticket showing the meter reading at the commencement of the yield test and the completion of each placing operation shall be submitted to the Contract Administrator.

When their quantities are included on the meter register ticket deductions shall be made for concrete produced in excess of that required for the placing operation and for that concrete placed on the deck more than 125 mm from the finished edge, after saw cutting of the overlay.

The total volume shall be calculated to the nearest 0.1 m^3 .

930.09.02.05 Concrete Patches, Formed Surface Concrete Patches, Unformed Surface Concrete Refacing

930.09.02.05.01 By Area

Measurement shall be by area of the concrete placed in square metres to the depth as specified in the Contract Documents.

The total area will be calculated to the nearest 0.1 m^2 .

930.09.02.05.02 By Volume

Measurement shall be of the volume of concrete placed in cubic metres.

The total volume shall be calculated to the nearest 0.01 m^3 .

930.09.02.06 Latex Modified Mortar Patches

930.09.02.06.01 By Area

Measurement shall be by area of the mortar placed in square metres to the depth as specified in the Contract Documents.

The total area shall be calculated to the nearest 0.1 m^2 .

930.09.02.06.02 By Volume

Measurement shall be by volume of the mortar placed in cubic metres. The volume of in place latex modified mortar shall be calculated to the nearest 0.01 m^3 .

930.09.03 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

930.10 BASIS OF PAYMENT

- 930.10.01**
- Modification of Deck Drains - Item**
 - Drainage Tubes in Deck - Item**
 - Place Concrete Overlay - Item**
 - Place Latex Modified Concrete Overlay - Item**
 - Finish and Cure Concrete Overlay - Item**
 - Finish and Cure Latex Modified Concrete Overlay - Item**
 - Concrete Patches, Formed Surface - Item**
 - Concrete Patches, Unformed Surface - Item**
 - Latex Modified Mortar Patches - Item**
 - Concrete Refacing - Item**

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

TABLE 1
Concrete and Latex Modified Concrete Overlay

	Concrete Overlay, Patches and Refacing	Latex Modified Concrete Overlay
Cement Content	OPSS 1350	$390 \pm 6 \text{ kg/m}^3$
Maximum Nominal Size of Coarse Aggregate	13.2 mm	13.2 mm
Slump	$70 \text{ mm} \pm 20 \text{ mm}$	$180 \text{ mm} \pm 40 \text{ mm}^*$
Air Content	OPSS 1350	6.5% maximum *
Chemical Admixture	OPSS 1303	N/A
Latex Modifier	N/A	$122 \pm 3 \text{ kg/m}^3$
Nominal Minimum 28 Day Strength	30 MPa	30 MPa
* Five minutes after mixing.		

TABLE 2
Treatment of Cracks

	Maximum Width of a Crack mm	Depth mm		
		≤ 15.0	> 15.0 < Full Depth	Full Depth
Overlays and Patches to be Waterproofed and Paved	≥ 1.00	Repair	Repair	Repair
Exposed Facings, Overlays, and Patches	> 0.30	Repair or if the linear measurement of crack per m^2 is 20 m or greater, remove and replace concrete.	Repair or if the linear measurement of crack per m^2 is 10 m or greater, remove and replace concrete.	Repair or if the linear measurement of crack per m^2 is 5 m or greater, remove and replace concrete.

Appendix 930-A, November 2014
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

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

Designer Action/Considerations

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

