



Ontario Provincial Standards Unit
301 St. Paul St., 2nd Floor North
St. Catharines, ON L2R 7R4

Telephone: 1-844-718-1605
Fax: 905-704-2051

REVISION INFORMATION SHEET

ONTARIO PROVINCIAL STANDARDS FOR ROADS AND PUBLIC WORKS

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

MANUAL REVISION #10

NOVEMBER 2015

UPDATING ONTARIO PROVINCIAL STANDARDS FOR YOUR USE

Each roads and public works owner (Owner) is responsible for determining implementation dates and directions for use of Ontario Provincial Standards; therefore, manual holders are cautioned about immediately discarding superseded and cancelled standards.

A NOTE TO DESIGNERS OF MUNICIPAL CONTRACTS REGARDING APPENDICES

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

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

ACCESSING AND OBTAINING ONTARIO PROVINCIAL STANDARDS

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

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

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

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

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

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

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

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

YOU SHOULD REGISTER YOUR OPS MANUALS AND CDs

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

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

WAITING TO HEAR FROM YOU

If you have a suggestion to revise a standard or you have a standard that works in your ministry, municipality, or area, send it to the Head, OPS Administration, for review and possible inclusion into the Ontario Provincial Standards.

THIS MANUAL IS REVISED AS FOLLOWS:

Index Pages Volume 5

Remove the entire index and replace with the revised index.

Standard Specifications Volume 5

Superseded/Cancelled (Remove)		Revised/New (Insert)		Remarks
OPSS.PROV	Dated	OPSS.PROV	Dated	
182	April 2015	182	November 2015	“GENERAL SPECIFICATION FOR ENVIRONMENTAL PROTECTION FOR CONSTRUCTION IN AND AROUND WATERBODIES AND ON WATERBODY BANKS” See Summary of Revisions.
--	--	314	November 2015	“CONSTRUCTION SPECIFICATION FOR UNTREATED SUBBASE, BASE, SURFACE, SHOULDER, SELECTED SUBGRADE, AND STOCKPILING” See Summary of Revisions.
--	--	331	November 2015	“CONSTRUCTION SPECIFICATION FOR FULL DEPTH RECLAMATION WITH EXPANDED ASPHALT STABILIZATION” See Summary of Revisions.
--	--	333	November 2015	“CONSTRUCTION SPECIFICATION FOR COLD IN-PLACE RECYCLING” See Summary of Revisions.
--	--	335	November 2015	“CONSTRUCTION SPECIFICATION FOR COLD IN-PLACE RECYCLING WITH EXPANDED ASPHALT” See Summary of Revisions.
--	--	342	November 2015	“CONSTRUCTION SPECIFICATION FOR THE GRINDING OF CENTRELINE AND SHOULDER RUMBLE STRIPS IN ASPHALT” This is a NEW specification.

Superseded/Cancelled (Remove)		Revised/New (Insert)		Remarks
OPSS.PROV	Dated	OPSS.PROV	Dated	
--	--	401	November 2015	“CONSTRUCTION SPECIFICATION FOR TRENCHING, BACKFILLING, AND COMPACTING” See Summary of Revisions.
--	--	410	November 2015	“CONSTRUCTION SPECIFICATION FOR PIPE SEWER INSTALLATION IN OPEN CUT” See Summary of Revisions.
--	--	421	November 2015	“CONSTRUCTION SPECIFICATION FOR PIPE CULVERT INSTALLATION IN OPEN CUT” See Summary of Revisions.
721	November 2014	721	November 2015	“CONSTRUCTION SPECIFICATION FOR STEEL BEAM GUIDE RAIL AND CABLE GUIDE RAIL” See Summary of Revisions.
723	April 2015	723	November 2015	“CONSTRUCTION SPECIFICATION FOR ENERGY ATTENUATORS” See Summary of Revisions.

SUMMARY OF REVISIONS TO OPSS.PROV 182

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

- Specification title has changed
- Section 182.02, References, Ontario Ministry of Transportation Publications, added, Ontario Water Resources Act, removed, Fisheries and Oceans Canada retitled to Canadian and Provincial Policy, Fish and Wildlife Conservation Act, added
- Section 182.03, Definitions, Fisheries Protocol, added, Mitigation, added, Offsetting, added, Qualified Fisheries Assessment Specialist, added, Qualified Fisheries Contracts Specialist, added.
- Clause 182.04.01.01, Fish Salvage Licencing, has been rewritten.
- Clause 182.04.01.02, Fisheries Specialists, added.
- Subsection 182.07.03, Preservation of Riparian Vegetation, first paragraph rewritten.
- Subsection 182.07.04, Erosion and Sediment Control, rewritten.
- Subsection 182.07.05, Restoration of Disturbed Areas, added.
- Clause 182.07.06.01, Fish Salvage, first paragraph rewritten.
- Clause 182.07.06.02, Reporting Species at Risk, first paragraph rewritten
- Clause 182.07.06.04, Fisheries Specialist Services, added.
- Subsection 182.07.07, Contingency Measures, rewritten.
- Table 1, Qualified Fisheries Contracts Specialist - Monitoring Documentation, added.

SUMMARY OF REVISIONS TO OPSS.PROV 314

CONSTRUCTION SPECIFICATION FOR UNTREATED SUBBASE, BASE, SURFACE, SHOULDER, SELECTED SUBGRADE, AND STOCKPILING

The provincial version of OPSS 314 has been published in OPS Volume 5 as OPSS.PROV 314, mainly for MTO use.

Although OPSS.PROV 314 is based on OPSS 314, several revisions have been made to the technical information. It is recommended that users read the entire specification to become familiar with the differences. Below is a summary of the revisions:

- Specification title has changed
- Section 314.01, Scope, selected subgrade added.
- Section 314.02, References, OPSS 201 added.
- Section 314.03, Definitions, rewritten.
- Subsection 314.05.01, Aggregates, has been rewritten.
- Subsection 314.05.02, Water, has been added
- Section 314.06, Equipment has been added.
- Subsection 314.07.01, has been retitled and rewritten.
- Subsection 314.07.02, has been retitled and rewritten.
- Subsection 314.07.04, Shoulders, has been rewritten.
- Subsection 314.07.05, Compaction, has been rewritten.
- Subsection 314.07.06, Tolerances, has been rewritten.
- Subsection 314.07.07, Stockpiling, has been rewritten.
- Subsection 314.07.08, has been retitled and rewritten.
- Subsection 314.07.09, Submission of Grade Checks, has been rewritten.
- Section 314.08 Quality Assurance, has been rewritten.
- Clause 314.09.01.01, has been rewritten.
- Clause 314.09.01.01.02, has been rewritten
- Subsection 314.10.01, has been rewritten.
- Certification of Grade Elevation / Crossfall Form removed.
- Tables 1 and 2 have been added.

SUMMARY OF REVISIONS TO OPSS.PROV 331

CONSTRUCTION SPECIFICATION FOR FULL DEPTH RECLAMATION WITH EXPANDED ASPHALT STABILIZATION

The provincial version of OPSS 331 has been published in OPS Volume 5 as OPSS.PROV 331, mainly for MTO use.

Although OPSS.PROV 331 is based on OPSS 331, several revisions have been made to the technical information. It is recommended that users read the entire specification to become familiar with the differences. Below is a summary of the revisions:

- Sections 331.02, 331.03, 331.04, 331.05 and 331.08 have been rewritten
- Subsection 331.06.01, Recycling Train, has been rewritten.
- Subsection 331.07.05, Grading and Compacting the Expanded Asphalt Mix, has been retitled and rewritten.
- Existing subsection 331.07.06, Sampling, has been deleted and moved to subsection 331.08.02. Following subsections have been renumbered.
- Existing subsection 331.07.07, Traffic Convoy, has been rewritten, renumbered 331.07.06 and retitled Traffic Control with Moving Vehicles.
- Subsection 331.07.08, Management of Excess Material, has been deleted.
- Subsection 331.10.01 has been rewritten.

SUMMARY OF REVISIONS TO OPSS.PROV 333

CONSTRUCTION SPECIFICATION FOR COLD IN-PLACE RECYCLING

The provincial version of OPSS 333 has been published in OPS Volume 5 as OPSS.PROV 333, mainly for MTO use.

Although OPSS.PROV 333 is based on OPSS 333, several revisions have been made to the technical information. It is recommended that users read the entire specification to become familiar with the differences. Below is a summary of the revisions:

- Sections 333.02, 333.03, 333.04, 333.05 and 333.08 have been rewritten
- Subsection 333.06.01, Recycling Train, has been rewritten.
- Subsection 333.07.07, Surface Appearance, has been retitled and rewritten.
- Existing subsection 333.07.09, Sampling, has been deleted and moved to subsection 333.08.02. Following subsections have been renumbered.
- Existing subsection 333.07.10, Traffic Convoy, has been rewritten, renumbered 333.07.09 and retitled Traffic Control with Moving Vehicles.
- Subsection 333.10.01 has been rewritten.

SUMMARY OF REVISIONS TO OPSS.PROV 335

CONSTRUCTION SPECIFICATION FOR COLD IN-PLACE RECYCLING WITH EXPANDED ASPHALT

The provincial version of OPSS 335 has been published in OPS Volume 5 as OPSS.PROV 335, mainly for MTO use.

Although OPSS.PROV 335 is based on OPSS 335, several revisions have been made to the technical information. It is recommended that users read the entire specification to become familiar with the differences. Below is a summary of the revisions:

- Sections 335.02, 335.03, 335.04, 335.05 and 335.08 have been rewritten
- Subsection 335.06.01, Recycling Train, has been rewritten.
- Existing subsection 335.07.08, Sampling, has been deleted and moved to subsection 335.08.02. Following subsections renumbered.
- Existing subsection 335.07.09, Traffic Convoy, has rewritten, renumbered 335.07.08 and retitled Traffic Control with Moving Vehicles.

SUMMARY OF REVISIONS TO OPSS.PROV 401

CONSTRUCTION SPECIFICATION FOR TRENCHING, BACKFILLING, AND COMPACTING

The provincial version of OPSS 401 has been published in OPS Volume 5 as OPSS.PROV 401, mainly for MTO use.

Although OPSS.PROV 401 is based on OPSS 401, several revisions have been made to the technical information. It is recommended that users read the entire specification to become familiar with the differences. Below is a summary of the revisions:

- Sections 401.02, Definitions, definition for Trench rewritten.
- Subsection 401.05.03, Cover Material, point c) added.
- Subsection 401.10.01, Trenching, Backfilling, and Compacting, reference to Extra Work revised to Change in the Work.
- Appendix 401-A, Ontario Provincial Standard Drawings references deleted.

SUMMARY OF REVISIONS TO OPSS.PROV 410

CONSTRUCTION SPECIFICATION FOR PIPE SEWER INSTALLATION IN OPEN CUT

The provincial version of OPSS 410 has been published in OPS Volume 5 as OPSS.PROV 410, mainly for MTO use.

Although OPSS.PROV 410 is based on OPSS 410, several revisions have been made to the technical information. It is recommended that users read the entire specification to become familiar with the differences. Below is a summary of the revisions:

- Section 410.01, Scope, has been rewritten.
- Section 410.02, References, CSA G401, ASTM B746 and WRC Manual of Sewer Condition Classification (MSCC) added.
- Section 410.03, Definitions, has been rewritten.
- Clause 410.05.01.03, Corrugated Steel Products, last paragraph added.
- Clause 410.05.01.07, Aluminum Alloy Pipe Products, added.
- Clause 410.07.12.05, Polyethylene Pipe, g) added.
- Clause 410.07.12.08, Corrugated Aluminum Alloy Structural Plate Pipe, added.
- Clauses 410.07.16.05, Deflection Testing of Pipe Sewers and 410.07.16.06, Closed Circuit Television (CCTV) Inspection deleted and replaced with 410.07.16.05, Post Installation Inspection.
- Subsection 410.07.17, Cleaning and Flushing of Pipe Sewers, rewritten.
- Section 410.08, Quality Assurance, added.
- Section 410.10, Basis of Payment, rewritten.
- Table 2, Deflection Testing of Pipe Sewers deleted and replaced with Table 2, Accepted Repair Methods
- Table 3, Gravity pipe Codes and Associated Pipe Condition Status, added.

SUMMARY OF REVISIONS TO OPSS.PROV 421

CONSTRUCTION SPECIFICATION FOR PIPE CULVERT INSTALLATION IN OPEN CUT

The provincial version of OPSS 421 has been published in OPS Volume 5 as OPSS.PROV 421, mainly for MTO use.

Although OPSS.PROV 421 is based on OPSS 421, several revisions have been made to the technical information. It is recommended that users read the entire specification to become familiar with the differences. Below is a summary of the revisions:

- Section 421.01, Scope, has been rewritten.
- Section 421.02, References, CSA G401, ASTM B746 and WRc Manual of Sewer Condition Classification (MSCC) added.
- Section 421.03, Definitions, has been rewritten.
- Clause 421.05.01.03, Corrugated Steel Products, last paragraph added.
- Clause 421.05.01.07, Aluminum Alloy Pipe Products, added.
- Clause 421.07.12.05, Polyethylene Pipe, g) added.
- Clause 421.07.12.08, Corrugated Aluminum Alloy Structural Plate Pipe, added.
- Subsection 421.07.13, Closed Circuit Television (CCTV) Inspection deleted and replaced with 421.07.13, Post Installation Inspection.
- Subsection 421.07.14, Cleaning and Flushing of Pipe Sewers, rewritten.
- Section 421.08, Quality Assurance, added.
- Section 421.10, Basis of Payment, rewritten.
- Table 1, Accepted Repair Methods and Table 2, Gravity Pipe Codes and Associated Pipe Condition Status, added.

SUMMARY OF REVISIONS TO OPSS.PROV 721

CONSTRUCTION SPECIFICATION FOR STEEL BEAM GUIDE RAIL AND CABLE GUIDE RAIL

- Subsection 721.05.01, Cable Guide Rail, 2nd paragraph, requirement for posts to be clean peeled added.

SUMMARY OF REVISIONS TO OPSS.PROV 723

CONSTRUCTION SPECIFICATION FOR ENERGY ATTENUATORS

- Section 732.02, References, ASTM A 325 updated.
- Section 723.03, Definitions, Reduced Exposure definition revised.
- New subsection 723.04.01, Design Requirements, added.
- New clause 723.04.02.01, added.
- Clause 723.09.01.01; Energy Attenuator – Permanent, Super Wide, added.
- Clause 723.09.01.02; Energy Attenuator – Temporary, Super Wide, added.
- Clause 723.09.01.03; Energy Attenuator – Relocation, Super Wide, added.
- Subsection 723.10.01; Energy Attenuator – Permanent, Super Wide – Item; Energy Attenuator – Temporary, Super Wide – Item; and Energy Attenuator – Relocation, Super Wide; added.
- Table 1, 2 and 3; Quadguard Super Wide System added.

MANUAL REVISION RECORD

Provincial-Oriented

Volume 5 – MTO General Conditions of Contract and General & Construction Specifications

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

REVISION NUMBER	REVISION DATE	ENTERED BY	REVISION NUMBER	DATE	ENTERED BY
1	APRIL 2008	Included in new manuals	27		
2	NOV 2008	Included in new manuals	28		
3	APR 2010	Included in new manuals	29		
4	NOV 2010	Included in new manuals	30		
5	APR 2012	Included in new manuals	31		
6	NOV 2012	Included in new manuals	32		
7	NOV 2013	Included in new manuals	33		
8	NOV 2014	Included in new manuals	34		
9	APRIL 2015	Included in new manuals	35		
10	NOV 2015	Included in new manuals	36		
11			37		
12			38		
13			39		
14			40		
15			41		
16			42		
17			43		
18			44		
19			45		
20			46		
21			47		
22			48		
23			49		
24			50		
25			51		
26			52		



DATE	SPEC. NO. OPSS.PROV	TITLE
MTO GENERAL CONDITIONS OF CONTRACT		
APR 2010	100	MTO General Conditions of Contract
DIVISION 1 - GENERAL SPECIFICATIONS		
NOV 2008	106	Notice to Users of OPSS 106 (Electrical Work)
NOV 2014	120	The Use of Explosives
NOV 2015	182	Environmental Protection for Construction in and Around Waterbodies and on Waterbody Banks
NOV 2012	185	Temporary Flow Control for Construction in Waterbodies
DIVISION 2 - GENERAL GRADING		
NOV 2013	202	Rock Removal by Manual Scaling, Machine Scaling, Trim Blasting, or Controlled Blasting
NOV 2014	203	Rock Stabilization
NOV 2014	206	Grading
NOV 2014	209	Embankments Over Swamps and Compressible Soils
NOV 2013	212	Earth Borrow
NOV 2014	220	Wick Drain Installation
DIVISION 3 - PAVEMENT (FLEXIBLE AND RIGID)		
APR 2012	308	Tack Coating and Joint Painting
APR 2007	313	Hot Mix Asphalt - End Result
NOV 2015	314	Untreated Subbase, Base, Surface, Shoulder, Selected Subgrade, and Stockpiling
NOV 2014	320	Open Graded Drainage Layer
NOV 2014	330	In-Place Full Depth Reclamation of Bituminous Pavement and Underlying Granular
NOV 2015	331	Full Depth Reclamation with Expanded Asphalt Stabilization
NOV 2015	333	Cold In-Place Recycling
NOV 2015	335	Cold In-Place Recycling with Expanded Asphalt



**ONTARIO
PROVINCIAL
STANDARD
SPECIFICATION**

VOLUME 5 INDEX

**PROVINCIAL-ORIENTED
MTO GENERAL CONDITIONS OF CONTRACT AND
GENERAL & CONSTRUCTION SPECIFICATIONS**

DATE	SPEC. NO. OPSS.PROV	TITLE
NOV 2015	342	Grinding of Centreline and Shoulder Rumble Strips in Asphalt
NOV 2014	355	Installation of Interlocking Concrete Pavers
NOV 2014	363	Repairing Rigid Pavement with Precast Concrete Slabs
NOV 2014	365	Cross-Stitching Longitudinal Cracks in Concrete Pavement and Concrete Base
DIVISION 4 - DRAINAGE, WATERMAINS, AND UTILITY		
NOV 2015	401	Trenching, Backfilling, and Compacting
NOV 2015	410	Pipe Sewer Installation in Open Cut
NOV 2015	421	Pipe Culvert Installation in Open Cut
DIVISION 5 - MISCELLANEOUS		
NOV 2014	501	Compacting
NOV 2014	510	Removal
NOV 2014	512	Installation of Gabions
NOV 2014	539	Temporary Protection Systems
DIVISION 6 - ELECTRICAL		
CURRENTLY NO SPECIFICATIONS		
DIVISION 7 - TRAFFIC SAFETY		
NOV 2015	721	Steel Beam Guide Rail and Cable Guide Rail
NOV 2015	723	Energy Attenuators
NOV 2014	732	Guide Rail End Treatment - Steel Beam Energy Attenuating Terminal Systems
NOV 2014	771	Standard Highway Fence
DIVISION 8 - ENVIRONMENTAL AND LANDSCAPE		
NOV 2014	804	Seed and Cover
DIVISION 9 - STRUCTURAL		
NOV 2014	904	Concrete Structures



**ONTARIO
PROVINCIAL
STANDARD
SPECIFICATION**

VOLUME 5 INDEX

**PROVINCIAL-ORIENTED
MTO GENERAL CONDITIONS OF CONTRACT AND
GENERAL & CONSTRUCTION SPECIFICATIONS**

DATE	SPEC. NO. OPSS.PROV	TITLE
NOV 2014	905	Steel Reinforcement for Concrete
NOV 2014	908	Metal Traffic Barriers and Metal Railings for Structures
APR 2008	910	Stressing Systems for Post-Tensioning
NOV 2014	911	Coating Structural Steel Systems
NOV 2014	914	Waterproofing Bridge Decks with Applied Asphalt Membrane
NOV 2014	915	Sign Support Structures
NOV 2008	920	Deck Joint Assemblies, Preformed Seals, Joint Fillers, Joint Seals, Joint Sealing Compounds, and Waterstops - Structures
APR 2012	928	Structure Rehabilitation - Concrete Removal
NOV 2014	930	Structure Rehabilitation - Concrete Patches, Refacing, and Overlays
NOV 2014	935	Impressed Current Cathodic Protection System for Bridge Structures



**ONTARIO
PROVINCIAL
STANDARD
SPECIFICATION**

VOLUME 5 INDEX

**PROVINCIAL-ORIENTED
MTO GENERAL CONDITIONS OF CONTRACT AND
GENERAL & CONSTRUCTION SPECIFICATIONS**



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

TABLE OF CONTENTS

182.01	SCOPE
182.02	REFERENCES
182.03	DEFINITIONS
182.04	DESIGN AND SUBMISSION REQUIREMENTS
182.05	MATERIALS
182.06	EQUIPMENT
182.07	CONSTRUCTION
182.08	QUALITY ASSURANCE - Not Used
182.09	MEASUREMENT FOR PAYMENT - Not Used
182.10	BASIS OF PAYMENT

APPENDICES

182-A	Commentary
--------------	-------------------

182.01	SCOPE
---------------	--------------

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

182.01.01 Specification Significance and Use

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

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

182.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

182.02 REFERENCES

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

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

Ontario Provincial Standard Specification, Construction

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

Ontario Ministry of Transportation Publications

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

Canadian and Provincial Statutes

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

Canadian and Provincial Policy

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

182.03 DEFINITIONS

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

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

Deleterious Substance means as defined by the Fisheries Act.

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

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

Fish means as defined by the Fisheries Act.

Fish Habitat means as defined by the Fisheries Act.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Waterbody Bank means the slope on or adjacent to a waterbody from the normal water level to the top of slope.

Watercourse means a stream, creek, river, or channel including ditches, in which the flow of water is permanent, intermittent, or temporary.

182.04 DESIGN AND SUBMISSION REQUIREMENTS

182.04.01 Submission Requirements

182.04.01.01 Fish Salvage Licencing

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

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

182.04.01.02 Fisheries Specialists

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

182.05 MATERIALS

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

182.06 EQUIPMENT

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

182.07 CONSTRUCTION

182.07.01 General Requirements

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

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

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

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

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

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

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

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

182.07.02 Operation of Equipment in Waterbodies or on Waterbody Banks

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

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

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

182.07.03 Preservation of Riparian Vegetation

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

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

182.07.04 Erosion and Sediment Control

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

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

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

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

182.07.05 Restoration of Disturbed Areas

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

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

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

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

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

182.07.06 Fish Protection

182.07.06.01 Fish Salvage

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

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

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

All persons conducting electrofishing shall possess valid Ontario Electrofishing Certification.

182.07.06.02 Reporting Species at Risk

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

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

182.07.06.03 Fish Screens

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

182.07.06.04 Fisheries Specialist Services

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

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

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

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

182.07.07 Contingency Measures

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

182.07.08 Management of Excess Materials

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

182.10 BASIS OF PAYMENT

Payment at the Contract price for the appropriate tender items that requires fisheries protection requirements and mitigation measures shall include full compensation for all labour, Equipment, and Material to do the work.

When the Contract contains separate items for work required by this specification, payment shall be at the Contract prices and according to the specifications for such work.

Table 1
Qualified Fisheries Contracts Specialist - Monitoring Documentation

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

Appendix 182-A, November 2015
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

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

Designer Action/Considerations

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



**CONSTRUCTION SPECIFICATION FOR UNTREATED SUBBASE,
BASE, SURFACE, SHOULDER, SELECTED SUBGRADE,
AND STOCKPILING**

TABLE OF CONTENTS

314.01	SCOPE
314.02	REFERENCES
314.03	DEFINITIONS
314.04	DESIGN AND SUBMISSION REQUIREMENTS - Not Used
314.05	MATERIALS
314.06	EQUIPMENT
314.07	CONSTRUCTION
314.08	QUALITY ASSURANCE
314.09	MEASUREMENT FOR PAYMENT
314.10	BASIS OF PAYMENT

APPENDICES

314-A	Commentary
--------------	-------------------

314.01 SCOPE

This specification covers the requirements for the construction of Subbase, Base, roadway surface, Shoulder, and edge ramping for bituminous pavements, selected subgrade and stockpiling at specified sites.

314.01.01 Specification Significance and Use

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

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

314.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

314.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 201	Clearing, Close Cut Clearing, Grubbing, and Removal of Surface and Piled Boulders
OPSS 350	Concrete Pavement and Concrete Base
OPSS 501	Compacting

Ontario Provincial Standard Specifications, Material

OPSS 1001	Aggregates - General
OPSS 1010	Aggregates - Base, Subbase, Select Subgrade, and Backfill Material

314.03 DEFINITIONS

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

Selected Subgrade means a granular material meeting the requirements of Select Subgrade Material (SSM), as specified in OPSS 1010, which is used to replace unsuitable native soils or raise the existing grade or both, in order to meet the final subgrade grading requirements, specified in the Contract Documents.

Tolerance means a construction working tolerance only that is considered to be:

- a) Minus when it is:
 - i. narrower than the Contract standard when pertaining to horizontal dimensions as measured from centreline, or
 - ii. lower in elevation than the Contract standard when pertaining to vertical dimensions.
- b) Plus when it is:
 - i. wider than the Contract standard when pertaining to horizontal dimensions as measured from centreline, or
 - ii. higher in elevation than the Contract standard when pertaining to vertical dimensions.

314.05 MATERIALS

314.05.01 Aggregates

Aggregates used for Base, Subbase and selected subgrade applications shall be according to OPSS 1010.

314.05.02 Water

Water shall be free of any contaminants that could adversely affect the environment or the placement and compaction of materials for Base, Subbase and selected subgrade applications.

314.06 EQUIPMENT

314.06.01 Water

Equipment used for applying water to granular materials in order to meet compaction requirements for Base, Subbase and selected subgrade applications shall be equipped with variable flow control to uniformly and completely wet the material without causing the material to be eroded away. The equipment operator shall also have the capability to monitor and change the flow while the equipment is moving.

314.07 CONSTRUCTION

314.07.01 Subbase, Base, Surface, and Selected Subgrade

All materials shall be kept free from clay and other types of deleterious material. Construction operations shall not disturb underlying work.

All materials shall be placed in uniform lifts without segregation.

Except as provided under the Modified Layer Compaction Method clause:

- a) Granular B, Type II shall be placed in accordance with the compaction methods specified in the Granular B, Type II clause such that the thickness of the compacted layer is not greater than 150 mm.
- b) All other materials shall be placed such that the thickness of the compacted layer is not greater than 150 mm.

In all cases, each lift shall be bladed to a smooth surface according to the required cross-section and maintained until placement of a subsequent lift, when applicable.

Prior to closing down operations for each Day, the Subbase material shall be bladed and compacted and, if necessary, covered with sufficient Base material to carry traffic.

The Base shall be maintained to the tolerances in grade and cross-section and to the specified density until Contract Completion or, if the Contract includes paving, until the Base surface is paved.

314.07.02 Winter Grading

Any areas where materials used for Subbase, Base, selected subgrade or other fill applications are being placed shall be free of ice and snow. Frozen material shall not be incorporated into the Work. Materials used for Subbase, Base, selected subgrade or other fill applications shall not be placed over frozen ground. However, one lift of material may be placed over frozen ground, as long as the final grading and compaction of that lift is done after the underlying material has thawed.

314.07.03 Edge Ramping of Bituminous Pavement

A ramp of the specified material shall be built along the outside edges of each bituminous pavement construction course. Such ramps shall be at a height level with the pavement course and fall away from its edge at a slope not steeper than 4H:1V. Care shall be taken to prevent any ramping material from being spilled or pushed onto the pavement. Any material that is spilled shall be removed immediately without damage to the pavement and the surface thoroughly cleaned with the use of a power broom or other suitable means.

Prior to paving any section, only sufficient material to construct the ramps shall be placed on the Shoulders. No other Shoulder material shall be placed until the conditions, as detailed in the Shoulders subsection, have been attained.

Edge ramps shall be completed prior to opening adjacent pavement to traffic.

314.07.04 Shoulders

Material used for shouldering shall be placed and compacted at locations and to the line, grade, and cross-section specified in the Contract Documents.

Prior to commencing Shoulder construction, all debris and deleterious material shall be removed from the Shoulder area.

Shouldering operations shall commence as soon as, but not before, the following pavement conditions are met:

a) Bituminous Pavements

Placement of material for shouldering operations shall not commence along any section of pavement, until at least 6 hours have elapsed from the time of completion of the final bituminous pavement course in that section. In addition, for pavement sections that are already open to traffic, all shouldering operations shall be completed within 24 hours of their commencement. In all cases where a pavement section is not yet open to traffic, the shouldering shall be completed prior to opening that pavement section to traffic.

b) Concrete Pavement and Concrete Base

Shouldering operations shall commence according to OPSS 350. Shouldering shall be completed prior to opening the concrete base or concrete pavement to traffic.

All Shoulder construction material shall be conveyed from the transport vehicle onto the Shoulder area. End dumping of Shoulder construction material directly on to the adjacent pavement surface or directly on to the Shoulder shall not be permitted. The material shall be uniformly distributed within the specified Shoulder limits without segregation. Grading and shaping operations shall confine all material to within the specified Shoulder limits without overspill.

Any Shoulder construction material deposited, dragged, or inadvertently placed on the pavement surface shall be removed immediately and the pavement surface shall be thoroughly cleaned with the use of a power broom or other suitable means.

314.07.05 Compaction

314.07.05.01 General

Each lift of material shall be compacted as specified below prior to the placement of the next lift.

The rate of placing material shall be controlled by the adequacy of the compaction obtained.

314.07.05.02 Compaction Requirements

314.07.05.02.01 Granular B, Type II

Material shall not be dumped into position, but shall be deposited on and pushed over the end of the lift being constructed by means of bulldozers or other approved equipment.

The placement of the first lift of material over wet or weak subgrade shall be monitored and the placement and compaction procedure modified as required, with the approval of the Contract Administrator, to minimize subgrade disturbance. Localized, unusually wet or weak subgrade areas shall be identified to the Contract Administrator for possible treatment.

In restricted zones, as specified in OPSS 501, Granular B, Type II shall be compacted using hand-operated vibratory equipment with a minimum operating mass of 400 kg and a maximum power output between 5.0 and 9.9 kW. Where confined areas are less than the minimum width and where such equipment can be used safely, then smaller vibratory hand-operated tampers shall be used. One hundred percent compaction coverage with a minimum of four passes shall be provided in all cases.

In non-restricted zones, Granular B, Type II shall be compacted using single drum, vibratory, smooth steel drum rollers, with a minimum operating mass of 5,000 kilograms and minimum operating dynamic force of 75 kN. One hundred percent roller pass coverage with a minimum number of four passes shall be provided. Each roller pass shall overlap the coverage of the preceding pass by a minimum of 0.5 m.

314.07.05.02.02 All Other Granular Materials

The compaction requirements shall be according to OPSS 501.

314.07.05.03**Modified Layer Compaction Method**

Material may be placed in layers thicker than permitted under the Subbase, Base, Surface, and selected subgrade subsection, subject to the following provisions:

- a) All materials, with the exception of Granular B, Type II shall be placed in uniform layers such that each layer shall have a depth of not more than 300 mm after compaction.
- b) Granular B, Type II shall be placed in uniform layers with a compacted depth not to exceed the values shown in Table 1 for various sizes of single drum, vibratory, smooth wheel drum rollers. Both the minimum operating mass and the minimum operating dynamic force requirements shown in Table 1 shall be met for the roller used. One hundred percent roller pass coverage with a minimum number of four passes shall be provided. Each roller pass shall overlap the coverage of the preceding pass by a minimum of 0.5 m.
- c) Prior to placing material in layers as described in a) or b) above depending on the type of granular material used, the ability of the proposed method to achieve satisfactory compaction shall be demonstrated to the satisfaction of the Contract Administrator by means of a two-lane trial area. The trial area location shall be approved by the Contract Administrator. At least 48 hours prior to any work commencing on the trial area, full details of the proposed placing and compacting system or systems, including the rate of placing, depth of layer, number and type of compaction units, and number of passes shall be submitted to the Contract Administrator. The areas designated to evaluate each system shall be of sufficient length to be representative of the proposed method and shall normally be approximately 150 m in length. Approval will follow within one Business Day after satisfactory completion of the compaction trial area.
- d) When the Contract Administrator, approves a system of placing and compacting, the system shall be used for the remainder of the work to which it is applicable, except that:
 - i. Should it be necessary at any time to change the system or any part of it, including the source of material or the rate of placing the material, approval to change the system shall be obtained from the Contract Administrator, who may require a further trial area.
 - ii. If, at any time, tests show that a previously-approved system is no longer producing the required degree of compaction, changes shall be made as necessary to satisfy the requirements of this specification.

314.07.06**Tolerances**

The surface of the uppermost layer of granular material and each granular course shall be bladed, shaped, and compacted to produce the grade and cross-section specified in the Contract Documents, within the tolerances shown in Table 2.

In the event of a conflict between meeting horizontal grading tolerances and meeting vertical grading tolerances, the vertical grading tolerances shall take precedence.

314.07.07**Stockpiling of Granular Material**

Sites for stockpile construction, specified in the Contract Documents, shall be cleared and grubbed, regardless of stockpile height, according to OPSS 201. Organic soil underlying the stockpile location shall be removed and the site cleaned up prior to stockpile construction. Stockpiles shall be constructed, including the supply and placement of a pad upon which the materials are to be stockpiled, according to OPSS 1001.

314.07.08 Grade Checks

The Contract Administrator shall be notified within 12 hours when each Subbase or Base course has been completed, including Shoulders, and prior to the next course being placed.

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

Grade checks shall be carried out on all finished granular surfaces. Grade checks of granular grading surfaces shall be based on horizontal and vertical grading tolerances, as specified in the Tolerances subsection. The grade shall be certified at the stations and offsets shown in the grading templates, or when grading templates are not available, at the frequency requirements shown for the layout specified elsewhere in the Contract Documents.

314.07.09 Submission of Grade Checks

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

When grading templates are available, the Contractor shall sign and certify on the grading template that the components of the work indicated on that template have been correctly constructed to the specified line and grade tolerances. If a template is not available, then the Contractor shall complete, sign, and submit MTO form PH-CC-820 to the Contract Administrator.

314.07.10 Management of Excess Material

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

314.08 QUALITY ASSURANCE

314.08.01 General

The Owner may conduct random QA grade checks to verify that the grade and cross-section are within the specified tolerances.

314.08.02 Acceptance

If the Contract Administrator chooses not to take QA grade checks or if the QA grade checks conform to those determined by the Contractor, the work shall then be accepted.

However, if any discrepancies between the QA and the Contractor's grade checks are found, then, at the discretion of the Owner, additional QA grade checks may be carried out in any other location.

If the finished grade or cross-section or both are not within the tolerances specified in the Tolerances subsection, then:

- a) The Contract Administrator shall notify the Contractor and advise where the tolerances have not been met, including overbuilding of the width of a granular course.
- b) The Contractor shall be charged for each station where the tolerances have not been met, at the rate specified in the Basis of Payment section.
- c) The Contractor shall bring the granular surface to within the specified tolerances for grade, at no additional cost to the Owner.

314.09 MEASUREMENT FOR PAYMENT

314.09.01 Actual Measurement

**314.09.01.01 Granular A, B Type I, B Type II, B Type III, M and O
Granular A, B Type I, B Type II, B Type III, M, and O Stockpiled
Granular A, B Type I, B Type II, B Type III, M, and O from Stockpile
Select Subgrade Material, Compacted**

314.09.01.01.01 Tonne

When payment is by the tonne:

- a) When the Contractor supplies Granular A and M composed of air-cooled iron blast-furnace slag or nickel slag, the payment quantities shall be determined by applying the following factors:
 - i. The total measured mass of air-cooled iron blast-furnace slag incorporated into the work shall be multiplied by a factor of 1.116.
 - ii. The total measured mass of nickel slag incorporated into the work shall be multiplied by a factor of 0.85.
- b) When Granular B is composed of slag, the payment quantities shall be determined by comparing the density of the material to the average density of granular material as set by the Owner for that specific area and applying the conversion factors that have been determined to the weighed tonnes.
- c) When granular material is composed of slag, it is necessary to determine the amount of overrun or underrun. Such overrun and underrun shall be the difference between the tender quantity and the payment quantity as determined by applying the foregoing factors to the weighed tonnes.

314.09.01.01.02 Cubic Metre

When payment is by cubic metre, one of the following methods shall be used as determined by the Contract Administrator:

a) End Area Method

i. At Source

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

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

The volume of boulders removed from borrow pits that cannot be accommodated in embankments or any other areas acceptable to the Owner, shall be deducted.

ii. In Place

When the measurement for payment of material in its original location is impractical, the measurement for payment shall be made of material measured in place with no allowance for shrinkage and computed in cubic metres by the method of average end areas.

b) Truck Box Method

The truck box method shall only be used when the Contract Administrator deems that the quantities are too small or the end area method is impractical for other reasons.

In this case, measurement for payment shall be based on the total volume in cubic metres of loose granular material, calculated by the Contract Administrator, from estimated percentages of the pre-determined capacity of each truck box determined from measurements of its dimensions.

Each truck that the Contractor intends to use shall be uniquely and readily identifiable to the satisfaction of the Contract Administrator.

314.09.01.01.03 Square Metre

When payment is by square metre, the area shall be based on that shown in the Contract Documents.

314.09.02 Plan Quantity Measurement

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

314.10 BASIS OF PAYMENT

- 314.10.01 Granular A - Item**
Granular A, Stockpiled - Item
Granular A, from Stockpile - Item
- Granular B Type I - Item**
Granular B Type I, Stockpiled - Item
Granular B Type I, from Stockpile - Item
- Granular B Type II - Item**
Granular B Type II, Stockpiled - Item
Granular B Type II, from Stockpile - Item
- Granular B Type III - Item**
Granular B Type III, Stockpiled - Item
Granular B Type III, from Stockpile - Item
- Granular M - Item**
Granular M, Stockpiled - Item
Granular M, from Stockpile - Item
- Granular O - Item**
Granular O, Stockpiled - Item
Granular O, from Stockpile - Item
- Select Subgrade Material, Compacted - Item**

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

As specified in the Acceptance subsection, \$250.00 shall be deducted from payment for each station where the QA grade check of the finished grade is found to be outside of the specification limit.

Any additional grading carried out to correct grades that are not within the tolerances specified in the Tolerances subsection shall be carried out at no additional cost to the Owner.

Where a finished granular course exceeds the horizontal tolerances specified in the Tolerances subsection and the material outside that tolerance has been left in place, the Owner shall deduct from payment the theoretical quantity of material placed outside of that tolerance, based on a conversion factor of 2.0 t/m³, regardless of the type of granular material used.

TABLE 1
Modified Layer Compaction Thickness for Granular B, Type II
Single Drum, Vibratory, Smooth Wheel Drum Roller

Minimum Operating Mass kg	Minimum Operating Dynamic Force kN	Maximum Layer Depth After Compaction mm
5,000	75	300
8,000	150	450
12,000	250	600
15,000	350	750

TABLE 2
Allowable Tolerances for Finished Granular Surfaces

Tolerances From Specified Grade and Cross - Section	Finished Granular Courses mm	Finished Granular Surfaces Immediately Beneath Bituminous Courses, Sidewalks, and Curb and Gutter mm		Finished Granular Surfaces Immediately Beneath Concrete Courses, Sidewalks, and Curb and Gutter mm
		When the Finished Grade is Controlled by Fixed Components Such as Existing Pavements and Curbs	All Others	
Vertical	+ 30 - 30	+ 10 - 10	+ 30 - 30	+ 10 - 10
Horizontal	+ 30 - 0	+ 10 - 0	+ 30 - 0	+ 10 - 0
Surface Deviation (Note 1)	15	10		10
Notes: 1. The maximum gap between a granular surface and the underside of a 3 m rigid metal straightedge, placed anywhere and in any direction on that surface.				

Appendix 314-A, November 2015
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

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

Designer Action/Considerations

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR FULL DEPTH RECLAMATION WITH EXPANDED ASPHALT STABILIZATION

TABLE OF CONTENTS

331.01	SCOPE
331.02	REFERENCES
331.03	DEFINITIONS
331.04	DESIGN AND SUBMISSION REQUIREMENTS
331.05	MATERIALS
331.06	EQUIPMENT
331.07	CONSTRUCTION
331.08	QUALITY ASSURANCE
331.09	MEASUREMENT FOR PAYMENT
331.10	BASIS OF PAYMENT

APPENDICES

331-A	Commentary
--------------	-------------------

331.01 SCOPE

This specification covers the requirements for in-place full-depth reclamation of the existing hot mix asphalt (HMA) pavement and underlying granular base; shaping and compacting the unstabilized material; if required, adding and blending corrective aggregates or active filler or both; adding and mixing expanded asphalt; and shaping and compacting the expanded asphalt mix.

331.01.01 Specification Significance and Use

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

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

331.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

331.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 301	Restoring Unpaved Roadway Surfaces
OPSS 313	Hot Mix Asphalt - End Result
OPSS 501	Compacting

Ontario Provincial Standard Specifications, Material

OPSS 1010	Aggregates - Base, Subbase, Select Subgrade, and Backfill Material
OPSS 1101	Performance Graded Asphalt Cement
OPSS 1301	Cementing Materials

Ministry of Transportation Publications

MTO Laboratory Testing Manual:

LS-200	Penetration of Bituminous Materials
LS-282	Quantitative Extraction of Asphalt Cement and Analysis of Extracted Aggregate from Bituminous Paving Mixtures
LS-297	Determination of Indirect Tensile Strength of Expanded Asphalt Mixes
LS-602	Sieve Analysis of Aggregates
LS-625	Sampling of Granular Materials
SP-027	Manual for Assessment of Surface Defects of In-Place Recycled Pavement Mats

American Association of State Highway and Transportation Officials (AASHTO)

T40-02 Sampling Bituminous Materials

Wirtgen GmbH Publication

Wirtgen Cold Recycling Technology manual, 1st edition, 2012

331.03 DEFINITIONS

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

Active Filler means substances that chemically alter the mix properties.

Corrective Aggregate means virgin aggregate or reclaimed asphalt pavement (RAP) or both added to the reclaimed materials to meet the expanded asphalt mix requirements.

Expanded Asphalt means heated asphalt cement expanded from its normal volume by the addition of water.

Expanded Asphalt Mix (EAM) means the mixture of reclaimed materials; corrective aggregate or active filler or both, if required; and expanded asphalt.

Expanded Asphalt Mix (EAM) Mat means a pavement course which comprises Expanded Asphalt Mix.

Hot Mix Asphalt (HMA) means as defined in OPSS 313

Performance Graded Asphalt Cement (PGAC) means as defined in OPSS 313.

Quality Assurance (QA) means as defined in OPSS 313.

Reclaimed Asphalt Pavement (RAP) means as defined in OPSS 313.

Reclaimed Material means the mixture of reclaimed existing asphalt pavement and granular base.

Unstabilized Material means the mixture of reclaimed existing asphalt pavement and granular base; and corrective aggregate or active filler or both, if required.

331.04 DESIGN AND SUBMISSION REQUIREMENTS

331.04.01 Design Requirements

For mix design purposes, prior to commencing the work the Contractor shall obtain samples representative of the material that is produced during in-place full-depth reclamation. These samples shall be used to establish the design rate of expanded asphalt as a per cent by mass of the unstabilized material and to establish the necessity for corrective aggregate and/or active filler. The dry tensile strength shall be a minimum of 225 kPa and the wet tensile strength shall be a minimum of 100 kPa.

For bidding purpose only, the design rate of the expanded asphalt shall be as specified in the Contract Documents.

The mix design shall be carried out according to the Wirtgen Cold Recycling Technology manual using briquettes produced according to LS-297. The mix design shall be completed by a laboratory with Canadian Council of Independent Laboratories (CCIL) Type A certification or equivalent equipped to carry out expanded asphalt mix designs. When the existing pavement significantly changes composition, a separate mix design shall be completed.

Each mix design shall include the following:

- a) Information on the grade, manufacturer, and supplier of the PGAC.
- b) The percent by mass of expanded asphalt in the mix, referred to as the design rate, and all calculations performed to determine the design rate of expanded asphalt.
- c) The recommended PGAC temperature for foaming, the half-life, the expansion ratio and the percent of water added for foaming.
- d) The optimum moisture content and the mix design bulk relative density.
- e) The dry tensile strength, the wet tensile strength, and the tensile strength ratio.
- f) The amount of water to be added to the mix.
- g) Maximum field rate adjustment allowed to the design rate without adverse effects to mix properties.
- h) Recovered penetration for the binder of the existing pavement according to LS-200.
- i) Type, source, gradation and quantity of corrective aggregate, if required.
- j) Type, source and quantity of active filler, if required.

331.04.02 Submission Requirements

A copy of the mix design shall be submitted to the Contract Administrator a minimum of 7 Business Days prior to the start of EAM operations. Within 4 Business Days after receiving the mix design, the Contract Administrator shall provide written confirmation of receipt of the submitted mix design documents or of any non-conformance to the contract requirements.

Confirmation of receipt of the mix design documents does not constitute any guarantee that the mix can be produced or constructed or both to Contract requirements, and does not relieve the Contractor of the responsibility for ensuring the specified quality of Materials and workmanship.

A new mix design shall be submitted when the expanded asphalt design rate is adjusted by 0.3% or greater. Separate or new mix designs shall be submitted if the composition or layer thicknesses of the existing pavement changes significantly. Where more than one mix design is required, the area for which each mix design is to be used shall be clearly identified.

331.05 MATERIALS

331.05.01 Performance Graded Asphalt Cement

PGAC shall be according to OPSS 1101. The Additional Testing Requirements and Acceptance Criteria for PG Grades table shall not apply. PGAC shall be selected with performance properties meeting the design maximum pavement temperature of 52 °C and the minimum pavement temperature of -28 °C at a minimum, and the selected PGAC shall have suitable expansion characteristics.

331.05.02 Corrective Aggregates

If required by the mix design, corrective aggregate shall be incorporated into the reclaimed material at the application rate determined in the mix design. Corrective aggregate shall meet the physical property requirements of OPSS 1010 for Granular A.

331.05.03 Active Filler

If required by the mix design, active filler shall be incorporated into the reclaimed material at the application rate determined in the mix design.

When used as active filler, Portland cement shall be according to OPSS 1301. Not more than 1% by mass of Portland cement shall be added to the mix.

331.05.04 Water

Water shall be clean and free from oil, acid, alkali, organic matter or other deleterious substances.

331.05.05 Expanded Asphalt Mix

The EAM shall be 100% passing the 37.5 mm sieve, and 95% to 100% passing the 26.5 mm sieve, and shall be measured based on air dried gradation according to coarse sieving operation of LS-602.

331.06 EQUIPMENT

331.06.01 Full-Depth Reclamation and Stabilization Equipment

The reclaimer-stabilizer shall be capable of reclaiming the existing asphalt pavement and underlying granular base to the depths specified in the Contract Documents, incorporating corrective aggregate or active filler or both into the mix, adding expanded asphalt in a controlled manner, and producing a uniform mix.

The reclaimer-stabilizer shall be fitted with an automatic sensor system to accurately maintain a preset depth of cut within a tolerance of 10 mm and shall have a minimum 2.0 m wide cutting drum.

The reclaimer-stabilizer shall have an asphalt cement expansion system capable of producing optimum expansion and an injection system capable of injecting and blending expanded asphalt uniformly throughout the unstabilized material. In order to mix the unstabilized material with the expanded asphalt, the reclaimer-stabilizer shall include the following features:

- a) A system to control and regulate the application of expanded asphalt in relation to travel speed and mass of material within a tolerance of $\pm 3.0\%$ by volume of asphalt cement.
- b) A system to monitor and control all aspects of the mixing process, including percent expanded asphalt, rate of application, and percent water for optimum compaction.
- c) A system of nozzles that provides uniform application of the expanded asphalt across the full width of treatment. The application system shall be adjustable for varying widths of treatment.

The aggregate delivery vehicle shall have a system for controlled application of the corrective aggregate.

331.06.02 Placing Equipment

A mechanical paver capable of spreading the mix evenly in front of the screed in one continuous pass to the specified cross-fall and grade shall be used to place the EAM. The paver shall be equipped with distributing augers for the full width to be paved. The paver shall have a vibratory screed capable of vibrating the full width of mix placed.

331.06.03 Pilot Vehicle

The pilot vehicle used to control traffic shall be according to OTM, Book 7.

331.07 CONSTRUCTION

331.07.01 Operational Constraints

In-place full depth reclamation including mixing, shaping and compacting to final grade shall be completed across the full pavement width prior to closing down operations each day.

The existing shoulders shall be shaped and compacted to match the adjacent lane prior to closing down operations each day.

Expanded asphalt stabilization shall not proceed during periods of rain or when the surface is in a saturated condition.

Traffic, including construction traffic, shall be kept off the freshly placed EAM until such time as it is able to carry traffic without damage. The Contractor shall be responsible for repair of damaged EAM.

The HMA course(s) shall not be placed on the EAM until the following requirements have been met:

- a) The EAM has been allowed to cure for a minimum of 3 Days.
- b) It has been demonstrated that the EAM meets all the requirements of this specification.
- c) All defective areas in the EAM have been repaired to the satisfaction of the Contract Administrator.

331.07.02 In-Place Full-Depth Reclamation

The existing asphalt pavement and underlying granular base shall be reclaimed to the depths and widths specified in the Contract Documents.

The graded surface of the reclaimed material, including existing shoulders shall be according to the surface tolerance requirements of OPSS 301. Reclaimed material exceeding 50 mm in size shall be removed from the work. The material shall be compacted according to OPSS 501.

331.07.03 Expanded Asphalt Trial Section

Prior to carrying out expanded asphalt stabilization, the Contractor shall demonstrate to the Contract Administrator the ability to successfully carry out expanded asphalt stabilization according to this specification by placing a trial section within the Contract limits.

In lieu of a trial section, the Contract Administrator may accept evidence that the Contractor has demonstrated the ability to successfully mix, handle, place, and compact EAM with the same equipment, placing crew, and methodology to meet the Contract requirements for placing EAM on another Contract within the last 12 months.

The trial section shall be a minimum of 3,500 m² or the equivalent of one tanker load of asphalt cement. The Contractor shall propose the location of the trial section to the Contract Administrator for approval. A minimum of 48 hours notice shall be given to the Contract Administrator prior to placing the trial section.

The Contract Administrator shall allow the Contractor to continue the expanded asphalt stabilization work based on an acceptable visual assessment of the trial section according to the requirements of the Grading and Compacting the Expanded Asphalt Mix subsection. When EAM is rejected by visual assessment, the Contractor shall repeat additional trial sections until the EAM meets the requirements of the Surface Appearance subsection.

The Contractor shall be responsible for the repair, removal, or replacement of an unacceptable trial section according to the Repairing and Re-Evaluating subsection.

331.07.04 Expanded Asphalt Stabilization

Expanded asphalt stabilization shall be to the depth and limits detailed in the Contract Documents. The overlap between successive passes of the reclaimer-stabilizer shall be a minimum of 100 mm and a maximum of 150 mm.

If required, corrective aggregate or active filler or both shall be added to the roadway prior to stabilizing.

In areas that are inaccessible to the reclaimer-stabilizer equipment, existing asphalt pavement shall be removed and replaced with a minimum 100 mm of binder course hot mix placed flush with the adjacent EAM surface.

331.07.05 Compacting the Expanded Asphalt Mix

The surface of the EAM shall be uniform in texture and free of surface defects.

Granular material shall be compacted according to OPSS 501.

The compacted surface of the EAM shall be according to the surface tolerances as specified in this specification.

331.07.06 Traffic Control with Moving Vehicles

Traffic shall be controlled with moving vehicles according to OTM, Book 7.

The moving vehicles shall guide one-way traffic through or around construction. The maximum speed of the moving vehicles shall be 30 km/h. Traffic control with moving vehicles shall be maintained until such time as the expanded asphalt stabilization is able to carry traffic without damage.

331.08 QUALITY ASSURANCE

331.08.01 General

Acceptance of the EAM shall be based on the following criteria:

- a) Surface Appearance
- b) Asphalt Cement Content
- c) Tensile Strength of EAM
- d) Thickness

- e) Surface Tolerance
- f) Compaction
- g) EAM Gradation
- h) Corrective Aggregates, if required.

Work that does not meet the acceptance criteria shall be repaired according to the Repairing and Re-Evaluating subsection.

331.08.02 Sampling

331.08.02.01 Lot Size

A lot size shall be a maximum of 50,000 m² of expanded asphalt stabilization divided into 10 sublots of equal size. The lot size may be adjusted at the discretion of the Contract Administrator and after discussion with the Contractor, prior to starting the work and when changes occur in the mix design or in the sequence of expanded asphalt stabilization. The maximum subplot size shall be 5,000 m². The minimum number of sublots in a lot shall be three.

331.08.02.02 Performance Graded Asphalt Cement

Samples of PGAC to be used in the mix shall be taken from the storage tank at the terminal according to the Tank Tap Method specified in AASHTO T40-02 and the terminal's health and safety plan in the presence of the Contract Administration at a frequency of three sets of samples per Contract for PGAC providing to three different lots. Each set of samples shall be a minimum of 2 full one-litre portions. The Contractor's health and safety plan and procedure for sampling shall be reviewed at the pre-pave meeting.

Sample containers supplied by the Contractor shall be triple tight steel containers or suitable containers that can be sealed to prevent leakage or contamination.

331.08.02.03 Corrective Aggregate

Where the quantity of corrective aggregate is greater than 5,000 tonnes, two 25 kg samples shall be taken in the presence of the Contract Administrator for each 25,000 tonnes of material produced, and whenever material is produced from a new source or new bench in a quarry, or whenever a significant change in production of materials occurs.

QA samples shall be taken in accordance with procedures given in LS-625 and at the time and location determined by the Contract Administrator.

331.08.02.05 Expanded Asphalt Mix

For the purpose of accepting the asphalt cement content, samples of unstabilized material and EAM shall be taken at a minimum frequency of one set of samples per subplot. To obtain a set of samples, one 15 kg sample of unstabilized material shall be obtained immediately following in-place full depth reclamation and, from the same approximate location, a second 15 kg sample of EAM immediately following stabilization. The maximum sampling depth shall be 100 mm. The second sample may be obtained after placement and prior to compaction.

For the purpose of determining the EAM gradation, another 30 kg sample of EAM shall be taken from each of three randomly selected sublots for every lot.

The samples shall be packaged in non-absorptive materials to protect sample integrity and sealed in waterproof containers. The samples shall be transported in a manner that avoids stacking and extreme temperatures.

331.08.03 Acceptance Criteria

331.08.03.01 Surface Appearance

Surface appearance shall be assessed by the Contract Administrator based on SP-027 manual after the EAM mat has been opened to traffic. The finished EAM surface shall have a uniformly smooth texture and be free from surface defects of ravelling, deformation, flushing, and rutting prior to placement of the HMA overlay.

331.08.03.02 Asphalt Cement Content

For each subplot, the sample of unstabilized material taken immediately following in-place full depth reclamation and the sample of EAM taken immediately after stabilization, shall be tested for total asphalt cement content according to LS-282. The total asphalt cement content of the EAM includes existing aged asphalt cement and new asphalt cement. The per cent by mass of new asphalt cement added to the unstabilized material shall be determined from the two samples at each location by subtracting the total asphalt cement content of the unstabilized material from the total asphalt cement content of the EAM.

The average new asphalt cement content of a lot shall not be less than 0.4% or more than 0.6% of the established mix design.

331.08.03.03 Tensile Strength

Samples of EAM shall also be tested for dry tensile strength and wet tensile strength according to LS-297.

Dry tensile strength requirements for the lot are met when the following are satisfied:

- a) The mean dry tensile strength of the lot is equal to or greater than 225 kPa; and
- b) No individual subplot dry tensile strength is less than 200 kPa.

Wet tensile strength requirements for the lot are met when the following are satisfied:

- a) The mean wet tensile strength of the lot is equal to or greater than 100 kPa; and
- b) No individual subplot wet tensile strength is less than 75 kPa.

EAM that does not meet the above dry tensile strength and wet tensile strength requirements shall be deemed rejectable.

331.08.03.04 Thickness

Thickness of the EAM shall be measured by the Contract Administrator at a minimum frequency of one thickness measurement per subplot. Measurements shall be taken by excavating along the edge of the stabilized pass with a shovel and measuring the depth of stabilization from the bottom of the EAM to the surface of the adjacent unstabilized material. Thickness requirements for the lot are met when the following are satisfied:

- a) At least 90% of all thickness measurements are equal to or greater than the specified thickness minus 20 mm, and

- b) No individual thickness measurement for the lot is less than the specified thickness minus 30 mm.

331.08.03.05 Surface Tolerance

The surface tolerance of any EAM surface shall be such that when tested with a 3 m straight edge placed anywhere on the EAM surface, including the edge of the EAM, in any direction on the surface, there shall not be a gap between the bottom of the straight edge and the surface of the EAM greater than 10 mm according to OPSS 301.

331.08.03.06 Compaction

Compaction measurements shall be taken by the Contract Administrator according to OPSS 501 for granular materials and at a minimum frequency of one QA measurement per subplot. Compaction requirements of the EAM placed for the lot are met when the following are satisfied:

- a) The lot average of all compaction measurements is greater than or equal to 97% of the target density; and
- b) No individual compaction measurement for the subplot is less than 95% of the target density.

331.08.03.07 Expanded Asphalt Mix Gradation

If the EAM does not meet the gradation requirements, the Contractor shall submit an action plan of mediation to the Contract Administrator for approval within 2 Business Days after the delivery of the QA testing results.

331.08.03.08 Corrective Aggregate

QA testing shall be carried out to ensure that corrective aggregate to be used in the work is according to the physical property requirements of Granular A according to OPSS 1010.

331.08.04 Repairing and Re-Evaluating

331.08.04.01 General

With the exception of repairs for surface tolerance, the minimum width of repair shall be the full lane width.

For repairs due to the surface appearance defects, the minimum repair length shall be sufficient for the repair to be carried out by the reclaimer-stabilizer equipment. For other repairs based on the lot and subplot acceptance, the minimum length shall be according to the Repairing and Re-Evaluating clause of OPSS 313. All repairs shall be made using the same equipment as was used during initial production and placement.

All repairs will be re-evaluated and retested according to Acceptance Criteria subsection.

331.08.04.02 Surface Appearance

Unacceptable EAM due to the surface appearance defects, including any area damaged or contaminated by traffic, by water added by Contractors during compaction, or by nature, shall be reprocessed by the reclaimer-stabilizer. If required, additional expanded asphalt shall be added during reprocessing.

Alternatively, the Contractor shall remove and replace damaged or otherwise unacceptable EAM with the same hot mix type to be used in the overlying hot mix lift to a minimum depth of 50 mm according to OPSS 313.

331.08.04.03 Asphalt Cement Content

For sublots with insufficient asphalt cement content, the EAM mat shall be reprocessed by the reclaimer-stabilizer with addition of asphalt cement during reprocessing. For sublots with excessive asphalt cement content, the EAM mat shall be reprocessed by the reclaimer-stabilizer with addition of corrective aggregates during reprocessing. The unacceptable sublots are repaired until the corresponding lot mean is within the acceptance tolerance.

331.08.04.04 Tensile Strength

The rejectable sublots shall be reprocessed by the reclaimer-stabilizer, if required, with addition of asphalt cement during reprocessing until the corresponding lot mean is above the acceptance criterion. Alternatively, the EAM mat shall be removed to a minimum depth of 50 mm and replaced by an appropriate HMA approved by the Contract Administrator.

331.08.04.05 Thickness

For sublots with insufficient thickness, the Contractor shall determine the limits of the unacceptance EAM based on additional measurement. The pavement segments with insufficient thickness shall be overlaid with binder course or surface course with additional thickness so as to compensate for the insufficient thickness as found in EAM layer.

331.08.04.06 Surface Tolerance

To meet the specified surface tolerance, all deficient areas shall be re-profiled by milling or padded with the same hot mix type to be used in the overlying hot mix lift.

331.08.04.07 Compaction

Mixes that cannot be compacted to the specified density shall be removed to a minimum depth of 50 mm and replaced by HMA approved by the Contract Administrator.

331.09 MEASUREMENT FOR PAYMENT

331.09.01 Actual Measurement

331.09.01.01 Full-Depth Reclamation with Expanded Asphalt Stabilization

Measurement of full-depth reclamation with expanded asphalt stabilization shall be by horizontal area in square metres.

331.09.02 Plan Quantity Measurement

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

331.10 BASIS OF PAYMENT

331.10.01 Full-Depth Reclamation with Expanded Asphalt Stabilization - Item

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

The addition of corrective aggregate, active filler or other additives, including any expanded asphalt that is required due to the additives, shall be at no extra cost to the Owner.

HMA required to replace unacceptable EAM shall be at no extra cost to the Owner.

PGAC shall be included in the Full-Depth Reclamation with Expanded Asphalt Stabilization item.

Repair of unacceptable EAM shall be carried out at no extra cost to the Owner.

The additional expanded asphalt, if required, added during reprocessing of unacceptable EAM shall be carried out at no extra cost to the Owner.

Repair of areas of EAM damaged by traffic shall be completed at no extra cost to the Owner.

Repair, removal, or replacement of an unacceptable trial section shall be completed at no extra cost to the Owner.

Appendix 331-A, November 2015

FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

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

Designer Action/Considerations

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR COLD IN-PLACE RECYCLING

TABLE OF CONTENTS

333.01	SCOPE
333.02	REFERENCES
333.03	DEFINITIONS
333.04	DESIGN AND SUBMISSION REQUIREMENTS
333.05	MATERIALS
333.06	EQUIPMENT
333.07	CONSTRUCTION
333.08	QUALITY ASSURANCE
333.09	MEASUREMENT FOR PAYMENT
333.10	BASIS OF PAYMENT

APPENDICES

333-A	Commentary
--------------	-------------------

333.01 SCOPE

This specification covers the requirements for cold in-place recycling of existing hot mix asphalt (HMA) pavement, sizing, adding active filler if required, adding and mixing emulsified asphalt, and spreading and compacting the cold in-place recycled (CIR) mix.

333.01.01 Specification Significance and Use

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

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

333.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

333.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 313 Hot Mix Asphalt - End Result

Ontario Provincial Standard Specifications, Material

OPSS 1103 Emulsified Asphalt
OPSS 1301 Cementing Materials

Ministry of Transportation Publications

MTO Laboratory Testing Manual:

LS-200 Penetration of Bituminous Materials
LS-291 Quantitative Extraction of Asphalt Cement and Mechanical Analysis of Extracted Aggregate from Bituminous Paving Mixtures - Ontario Procedure
LS-300 Preparation of Marshall Specimens for Cold In-Place Recycled Mixtures
LS-306 Bulk Relative Density of Compacted Bituminous Mixtures Using Paraffin Coated Specimens
LS-602 Sieve Analysis of Aggregates

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

SP-027 Manual for Assessment of Surface Defects of In-Place Recycled Pavement Mats

ASTM International

D6752/D 6752M-11 Standard Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Automatic Vacuum Sealing Method

333.03 DEFINITIONS

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

Active Filler means substances added to the reclaimed existing asphalt pavement that chemically alter the mix properties.

Cold In-Place Recycled (CIR) Mix means the in-place mixture of existing reclaimed HMA pavement, emulsified asphalt, and water.

Hot Mix Asphalt (HMA) means as defined in OPSS 313

Quality Assurance (QA) means as defined in OPSS 313.

Reclaimed Asphalt Pavement (RAP) means as defined in OPSS 313.

Target Density means the average bulk relative density for the lot established according to LS-300 by the QA testing laboratory, and used to determine the per cent compaction.

333.04 DESIGN AND SUBMISSION REQUIREMENTS

333.04.01 Design Requirements

For mix design purposes, prior to commencing the work, the Contractor shall obtain samples representative of the material that is produced during the milling operation. These samples shall be used to establish the design rate of emulsified asphalt as a percent by mass of the RAP. The design rate of the emulsified asphalt shall be a minimum of 1.2%.

The mix design shall be completed by a laboratory with Canadian Council of Independent Laboratories (CCIL) Type A certification or equivalent equipped to carry out CIR mix design. Where the existing pavement significantly changes composition, a separate mix design shall be completed.

Each mix design shall include the following:

- a) Information on the type, manufacturer, and supplier of the emulsified asphalt.
- b) The percent by mass of emulsified asphalt in the CIR, referred to as the design rate, and all calculations performed to determine the design rate of emulsified asphalt.
- c) The optimum moisture content and the mix design bulk relative density.
- d) The amount of water to be added to the mix.
- e) Maximum field rate adjustment allowed to the design rate without adverse effects to the mix properties.
- f) Recovered penetration for the binder of the existing pavement according to LS 200.

g) Type, source and quantity of active filler, if required.

333.04.02 Submission Requirements

A copy of the mix design shall be submitted to the Contract Administrator a minimum of 7 Business Days prior to the start of CIR operations. Within 4 Business Days after receiving the mix design, the Contract Administrator shall provide written confirmation of receipt of the submitted mix design documents or of any non-conformance to the contract requirements.

Confirmation of receipt of the mix design documents does not constitute any guarantee that the mix can be produced or constructed or both to Contract requirements, and does not relieve the Contractor of the responsibility for ensuring the specified quality of Materials and workmanship.

A new mix design shall be submitted when the emulsified asphalt design rate is adjusted by greater than 0.20%. Separate or new mix designs shall be submitted if the composition or layer thicknesses of the existing pavement changes significantly. Where more than one mix design is required, the area for which each mix design is to be used shall be clearly identified.

333.05 MATERIALS

333.05.01 Reclaimed Asphalt Pavement

RAP material shall be 100% passing the 37.5 mm sieve, and 95% to 100% passing the 26.5 mm sieve after processing, and shall be measured based on air dried gradation according to the coarse sieving operation of LS-602.

333.05.02 Emulsified Asphalt

Emulsified asphalt shall be polymer modified mixing grade according to OPSS 1103 and be compatible with the process and materials used.

333.05.03 Water

Water shall be clean and free from oil, acid, alkali, organic matter, or other deleterious substances.

333.05.04 Active Filler

When active filler is required, it shall be incorporated into the existing reclaimed asphalt pavement at the application rate specified in the mix design.

When used as active filler, Portland cement shall be according to OPSS 1301. Not more than 1% by mass of Portland cement shall be added to the mix.

333.06 EQUIPMENT

333.06.01 Recycling Train

The recycling train shall include the following:

- a) A self-propelled cold milling unit with a cutting drum capable of reclaiming a full lane width of asphalt pavement to the depth specified in the Contract Documents in one pass.
- b) A screening and sizing unit capable of processing the RAP.

- c) An aggregate feed system that measures and regulates the mass of RAP being added into the mixing unit prior to the addition of the emulsified asphalt. The scale shall be calibrated to the manufacturer's tolerance prior to the start of the work and when requested by the Contract Administrator.
- d) An emulsified asphalt control system equipped with a flow meter calibrated in litres per tonne and a total delivery meter calibrated in litres to continuously maintain the required amount of emulsified asphalt added to within 0.2% by mass of the reclaimed material feed.
- e) A means of monitoring and controlling the addition of water.
- f) A mixing unit capable of producing a uniform and thoroughly blended CIR mix.

333.06.02 Placing Equipment

A mechanical paver capable of spreading the mix evenly in front of the screed in one continuous pass to the specified crossfall and grade shall be used to place the CIR mix. The paver shall be equipped with distributing augers for the full width to be paved. The paver shall have a vibratory screed capable of vibrating the full width of mix placed.

333.06.03 Compaction Equipment

Compaction equipment shall be selected to achieve the required compaction.

333.06.04 Drying Unit

A drying unit specifically designed to provide radiant heat to the CIR mat may be used. Open flame heating shall not be used. The entire heater assembly shall be capable of readily adjusting the intensity of heat on the pavement surface.

333.06.05 Straight Edge

The straight edge shall be 3 m in length, metal, and have a level recessed in its upper edge parallel to the lower edge.

333.06.06 Pilot Vehicle

Pilot vehicles used to control traffic shall be according to OTM, Book 7.

333.07 CONSTRUCTION

333.07.01 General

HMA pavement in areas inaccessible to the reclaiming equipment shall be removed and replaced with acceptable binder course HMA. The HMA shall be placed to the CIR depth specified in the Contract Documents in compacted lift thicknesses between 40 and 75 mm in depth.

The overlap between successive passes of the recycling train shall be a minimum 100 mm.

333.07.02 Operational Constraints

The work shall not be carried out when the ambient temperature is less than 10 °C or when the overnight low is forecast to be less than 2 °C. Cold in-place recycled mix shall not be placed after September 1st without the written approval from the Contract Administrator. The work shall be carried out when the roadway is clean and free of standing water. The work shall not proceed during periods of rain or when the surface is in a saturated condition.

All traffic, including construction traffic, shall be kept off the freshly placed CIR mat until it is able to carry traffic without damage. Any damage to the CIR mat shall be repaired.

The wearing surface shall not be placed on the CIR mat until the following requirements have been met:

- a) The CIR mat has been opened to traffic and allowed to cure for a minimum of 14 Days.
- b) The specified moisture content has been achieved according to the Acceptance Criteria section.
- c) The specified density has been achieved according to the Compaction subsection.
- d) All defective areas in the CIR mat have been repaired to the satisfaction of the Contract Administrator.

The wearing surface shall be placed within 30 Days of placing the CIR mat. The 30 Day requirement may be waived by the Contract Administrator if the CIR mix does not meet the requirements of this specification and is subject to repair.

333.07.03 Cold In-Place Recycling Trial Section

Prior to carrying out CIR, the ability to successfully carry out CIR according to this specification shall be demonstrated to the Contract Administrator by placing a trial section within the Contract limits.

In lieu of a trial section, the Contract Administrator may accept evidence that the ability to successfully mix, handle, place, and compact CIR with the same equipment, placing crew, and methodology to meet the Contract requirements for placing CIR has been demonstrated on any Contract within the last 12 months.

The trial section shall be one lane width and 500 m in length. The location of the trial section shall be proposed to the Contract Administrator for approval. A minimum of 48 hours notice shall be given to the Contract Administrator prior to placing the trial section.

The Contract Administrator shall allow the CIR work to continue based on an acceptable visual assessment of the trial according to the requirements of the Surface Appearance subsection. When the CIR is rejected by visual assessment, the trial section shall be repaired or removed and replaced until the CIR meets the requirements of the Surface Appearance subsection.

333.07.04 Surface Preparation

When specified in the Contract Documents, milling prior to CIR work shall be carried out to achieve the specified crossfall and grade.

All deleterious and loose milled material shall be removed from the milled surfaces, and longitudinal and transverse joints after reclaiming operations are completed and before placing CIR mix.

Existing crack sealant shall be removed and disposed of prior to CIR reclaiming operations.

333.07.05 Mixing

The emulsified asphalt shall be added at the design rate. The rate of addition of emulsified asphalt shall be field adjusted as required to within 0.20% of the design rate and mixed to produce a uniformly coated CIR mix that can be compacted to the specified density. The emulsified asphalt added shall not be less than 1.2%.

Water may be added in a controlled manner to facilitate uniform mixing.

333.07.06 Compaction

The CIR mix shall be compacted according to the requirements of the Acceptance Criteria for Compaction subsection.

333.07.07 Surface Appearance

The compacted CIR mat shall be smooth and constructed to the crossfall and grade specified in the Contract Documents. The surface of the CIR mat shall be of uniform texture and free of segregation, raveling, rutting, longitudinal streaks, flushing, fat spots, oil spills, roller marks, and other defects.

333.07.08 Drying

Prior to the placement of the wearing surface, the Contractor may elect to use a drying unit. Overheating or burning of the CIR shall not be allowed.

333.07.09 Traffic Control with Moving Vehicles

Traffic shall be controlled with moving vehicles according to OTM, Book 7.

The moving vehicles shall guide one-way traffic through or around construction. The maximum speed of the moving vehicles shall be 30 km/h. Traffic control with moving vehicles shall be maintained until such time as the CIR mat is able to carry traffic without damage.

333.07.10 Management of Excess Material

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

333.08 QUALITY ASSURANCE

333.08.01 General

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

- a) Surface Appearance
- b) Surface Tolerance
- c) Moisture Content
- d) Compaction
- e) RAP Gradation

Work that does not meet the acceptance criteria shall be repaired according to the Repairing and Re-Evaluating subsection.

333.08.02 Sampling

333.08.02.01 Lot Size

The Contract Administrator shall determine the size and location of the lots and sublots after discussion with the Contractor and before CIR production starts. A lot shall typically represent 25,000 m² with 5 equal sublots of 5,000 m² in size.

333.08.02.02 Cold In-Place Recycling Material

Samples of CIR material shall be packaged in non-absorptive materials to protect sample integrity and sealed in waterproof containers. Samples shall be transported in a manner that avoids stacking and extreme temperatures.

333.08.02.02.01 Slabs

At least 4 Business Days prior to the planned overlay of the CIR mat, 2 slab samples of the CIR material shall be obtained from each subplot. The two slab samples shall be located side-by-side and taken at random locations as directed by the Contract Administrator. Each slab sample shall be dry cut 150 mm x 150 mm and removed intact from the CIR mat.

One slab sample shall be used to test for bulk relative density and the other slab sample shall be used to test for moisture content. The result of the moisture content will be used for both the moisture acceptance, and moisture adjustment for compaction calculation according to LS-306.

Additional slab samples for QA acceptance tests shall only be taken after the Contractor has carried out remedial work to improve moisture content and/or compaction in the rejected subplot. The Contractor shall be charged the cost of additional tests.

333.08.02.02.02 Loose Mix Samples

For the purpose of determining the RAP gradation, 30 kg of loose CIR mix samples shall be taken from each of two randomly selected sublots for every lot.

333.08.02.03 Reclaimed Material

At the start of production of each new lot or whenever the existing pavement material significantly changes composition, one 15 kg sample of material reclaimed from the roadway shall be obtained prior to adding emulsion for the purpose of determining the target density for compaction. Samples shall be taken at random locations as directed by the Contract Administrator.

333.08.02.04 Emulsified Asphalt

Samples of emulsified asphalt used in the mix shall be taken at the job site from the tankers according to the Contractor's health and safety plan at a frequency of three sets of samples per Contract randomly taken from three different lots. Each sample shall be taken either from a sampling spigot on the transfer line, if available, or from the end of the transfer line after a minimum of 4,000 kg has been drawn from the tanker. Each set of samples shall be a minimum of 2 full four-litre containers. The Contractor's health and safety plan and procedure for sampling shall be reviewed at the pre-pave meeting.

The sample containers supplied by the Contractor shall be new triple tight epoxy lined pails or suitable leak-proof plastic containers. The sample labels shall be obtained from the Contract Administrator.

333.08.03 Acceptance Criteria

333.08.03.01 Surface Appearance

Surface appearance shall be assessed by the Contract Administrator based on visual surveys after the CIR mat has been opened to traffic. The finished CIR surface shall have a uniformly smooth texture and shall meet the surface appearance requirements of ravelling, segregation and rutting as specified in Table 1 prior to placement of HMA overlay.

333.08.03.02 Surface Tolerance

The surface tolerance of any CIR surface shall be such that when tested with a 3 m straight edge placed anywhere on the CIR surface, except across the crown, and in any direction on the surface, there shall not be a gap between the bottom of the straight edge and the surface of the CIR greater than 6 mm.

333.08.03.03 Moisture Content

The QA laboratory shall test one sample from each subplot to determine the moisture content of CIR mix according to LS-291, and the test result of the moisture content shall be rounded to one decimal place according to LS-100. The test result for each subplot shall be used to compute the lot mean for moisture content of CIR mix.

The moisture content of CIR mix acceptance shall be based on the mean moisture content of the lot and the moisture content of the individual sublots. The lot is acceptable if the lot mean moisture content is equal to or less than 2% with no individual subplot's moisture content greater than 3%. The lot is rejectable if the lot mean moisture content of CIR mix is greater than 3%. Any subplot with its moisture content greater than 3% shall be deemed rejectable.

If the lot mean moisture content of CIR mix is less than 3% and greater than 2%, the Contractor may elect to accept a payment reduction or repair for the lot. The payment reduction shall be calculated according to Table 2. If the Contractor elects to repair the lot in lieu of a payment reduction, the lot shall be repaired according to the Repairing and Re-Evaluating subsection.

333.08.03.04 Compaction

The compaction of the CIR mix shall be calculated for each subplot from the bulk relative density determined from slab samples according to LS-306 or ASTM D-6752, and the target density for the lot as follows:

$$\text{Compaction} = (\text{bulk relative density of slab sample} / \text{target density}) \times 100\%$$

where the target density to be used for acceptance purposes shall be calculated for each lot from material reclaimed from the roadway prior to adding emulsion. The target density shall be established according to LS-300.

Each lot of CIR mix shall be compacted to a minimum mean of 96.0% of the target density established for the mix, with no individual subplot's bulk relative density result falling below 95.0% of the target density. CIR that is not compacted to the required density shall be deemed rejectable.

333.08.03.05 Reclaimed Asphalt Pavement Gradation

If the RAP does not meet the gradation requirements, the Contractor shall submit an action plan of remediation to the Contract Administrator for approval within 2 Business Days after the delivery of the QA testing results.

333.08.04 Repairing and Re-Evaluating

CIR mix that is rejectable based on the Acceptance Criteria subsection shall be repaired according to the requirements specified in Table 1.

Repairs shall be for the full lane width. For repairs due to surface appearance defects, the minimum repair length shall be sufficient for the repair to be carried out by the recycling train, or by the paving equipment, whichever is applicable. For other repairs based on the lot and subplot acceptance, the minimum length shall be according to the Repairing and Re-Evaluating clause of OPSS 313 and to the depth specified in Table 1.

The HMA required to repair unacceptable CIR shall be placed in compacted lift thicknesses between 40 and 75 mm. The HMA mix type and design used for repairs shall be approved by the Contract Administrator and shall meet the acceptance requirements for the HMA specified elsewhere in the Contract Documents.

All repairs will be re-evaluated and retested according to the Acceptance Criteria subsection.

When repairs are made to rejectable sublots or those sublots that the Contractor elects to repair due to the non-conformance of the moisture content requirements, the lot shall be re-evaluated and re-decisioned for payment reduction. The original lot shall be divided into two reconfigured lots in the following way: All acceptable sublots (with moisture content equal to or less than 2%) shall be grouped as one lot and shall receive the full Contract price. The remaining sublots shall be grouped as another lot and shall use the retest results of the repaired sublots to calculate the mean lot moisture content, and shall be accepted either at the full Contract price, or subjected to a payment reduction, or deemed rejectable.

333.09 MEASUREMENT FOR PAYMENT

333.09.01 Actual Measurement

333.09.01.01 Cold In-Place Recycled Mix

Measurement of CIR mix placed shall be by area in square metres.

333.09.02 Plan Quantity Measurement

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

333.10 BASIS OF PAYMENT

333.10.01 Cold In-Place Recycled Mix - Item

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

The addition of active filler or other additives to the mix, including any emulsion that is required due to the additives, shall be at no extra cost to the Owner.

HMA required to replace unacceptable CIR material shall be at no extra cost to the Owner.

Emulsified asphalt shall be included in the Cold In-Place Recycled Mix item.

Repair of an unacceptable CIR mat shall be carried out at no extra cost to the Owner.

HMA placed in areas inaccessible to the reclaiming equipment shall be included in the Cold In-Place Recycled Mix item.

Repair of areas of CIR damaged by traffic shall be completed at no extra cost to the Owner.

Repair, removal, or replacement of an unacceptable trial section shall be completed at no extra cost to the Owner.

333.10.02**Payment Reduction for Moisture Content**

When test results show that the moisture content payment factor for the lot is less than 1.000 and the Contractor is not required to or does not elect to repair the lot, the payment reduction for the lot shall be as follows:

$(1.000 - \text{Payment Factor}) \times \text{item price} \times \text{lot quantity}$

For purposes of payment reduction, the term item price means the Contract price of the applicable tender item.

For purposes of re-decision after repairs, the lot quantity is the area of the reconfigured lot.

TABLE 1
Acceptance Criteria and Repair Requirements for CIR Mix

Acceptance Criteria	Defect Type	Severity / Criteria	Acceptable / Rejectable	Repair Requirements
Surface Appearance	Ravelling/Coarse Aggregate Loss (Note 1)	Very Slight to Slight	Acceptable	No action required.
		Moderate to Severe	Rejectable	Mill 50 mm and replace with an acceptable binder course HMA (Note 2).
		Very Severe	Rejectable	Remove CIR to full depth and replace with an acceptable binder course HMA (Note 2).
	Segregation (Note 1)	Slight to Medium	Acceptable	No action required.
		Severe	Rejectable	Mill 50 mm and replace with an acceptable binder course HMA (Note 2).
	Rutting (Note 1)	Very Slight to Slight	Acceptable	No action required.
		Moderate to Severe	Rejectable	Mill 50 mm and replace with an acceptable binder course HMA (Note 2).
		Very Severe	Rejectable	Remove CIR to full depth and replace with an acceptable binder course HMA (Note 2).
Surface Tolerance	Non-conformance for surface tolerance as per the Surface Tolerance subsection of the Acceptance Criteria.	> 6 mm based on 3 m straight edge measurement	Rejectable	All deficient areas shall be re-profiled by milling or padded with the same hot mix type to be used in the overlying hot mix lift.
Moisture Content	Non-conformance for moisture Content as per the Moisture Content subsection of the Acceptance Criteria.	> 3% for Moisture Content of Lot or Individual Sublot	Rejectable	For rejected sublots, or sublots within the corresponding rejected lot: 1) Use drying unit as specified in the Drying Unit subsection to dry the CIR mat, or 2) Reprocess with a recycling train (Note 2), or 3) Remove CIR material to full depth and replace with an acceptable binder course HMA.
Compaction	Non-conformance for compaction as per the Compaction subsection of the Acceptance Criteria.	< 96% for Compaction of Lot; and < 95% for Compaction of Individual Sublot	Rejectable	For rejected sublots, or sublots within the corresponding rejected lot: 1) Recompect the CIR mat, if required, with reheating process, or 2) Reprocess with a recycling train (Note 2), or 3) Remove CIR material to full depth and replace with an acceptable binder course HMA.
Notes: 1) Defect and severity definitions according to SP-027. 2) Reprocessing with a recycling train may be considered as a repair method, upon submission of a proposal by the Contractor and approved by the Contract Administrator.				

TABLE 2
Moisture Content of CIR Mix Payment Factors

Moisture Content Payment Factors Acceptance Criteria	Classification	Payment Factor, PFT
MC ≤ 2%	Acceptable	1.000
2% < MC ≤ 3%	Payment Reduction	$1 - \text{TODRF} \times (\text{MC} - 2)/10$
MC > 3%	Rejectable	N/A

Where:

MC = the mean of the lot sample of moisture content of CIR Mix in percent calculated to one decimal place according to LS-100.

PFT = the payment factor for moisture content calculated to three decimal places according to LS-100.

TODRF = Tender Opening Date Reduction Factor according to Table 3.

TABLE 3
Tender Opening Date Reduction Factor

Year of Tender Opening	Tender Opening Date Reduction Factor
2015	0.65
2016	0.8
2017	1.0

Appendix 333-A, November 2015
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

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

Designer Action/Considerations

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR COLD IN-PLACE RECYCLING WITH EXPANDED ASPHALT

TABLE OF CONTENTS

335.01	SCOPE
335.02	REFERENCES
335.03	DEFINITIONS
335.04	DESIGN AND SUBMISSION REQUIREMENTS
335.05	MATERIALS
335.06	EQUIPMENT
335.07	CONSTRUCTION
335.08	QUALITY ASSURANCE
335.09	MEASUREMENT FOR PAYMENT
335.10	BASIS OF PAYMENT

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 active filler if required, adding and mixing expanded asphalt, and spreading and compacting the cold in-place recycled expanded asphalt mix (CIREAM).

335.01.01 Specification Significance and Use

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

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

335.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

335.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 313 Hot Mix Asphalt - End Result

Ontario Provincial Standard Specifications, Material

OPSS 1101 Performance Graded Asphalt Cement
OPSS 1301 Cementing Materials

Ministry of Transportation Publications

MTO Laboratory Testing Manual:

LS-200 Penetration of Bituminous Materials
LS-297 Determination of Indirect Tensile Strength of Expanded Asphalt Mixes
LS-306 Bulk Relative Density of Compacted Bituminous Mixtures Using Paraffin Coated Specimens
LS-602 Sieve Analysis of Aggregates

Ontario Traffic Manual (OTM):

OTM Book 7 - Temporary Conditions

SP-027 Manual for Assessment of Surface Defects of In-Place Recycled Pavement Mats

ASTM International

D 6752-11 Standard Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Automatic Vacuum Sealing Method

American Association of State Highway and Transportation Officials (AASHTO)

T40-02 Sampling Bituminous Materials

Wirtgen GmbH Publication

Wirtgen Cold Recycling Technology manual, 1st edition, 2012

335.03 DEFINITIONS

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

Active Filler means substances added to the reclaimed existing asphalt pavement that chemically alter the mix properties.

Cold In-Place Recycled Expanded Asphalt Mix (CIREAM) means the in-place mixture of existing reclaimed asphalt pavement (RAP), active filler, and expanded asphalt.

Cold In-Place Recycled Expanded Asphalt Mix (CIREAM) Mat means a pavement course which comprises Cold In-Place Recycled Expanded Asphalt Mix

Expanded Asphalt means heated asphalt cement expanded from its normal volume by the addition of water.

Hot Mix Asphalt (HMA) means as defined in OPSS 313.

Performance Graded Asphalt Cement (PGAC) means as defined in OPSS 313.

Quality Assurance (QA) means as defined in OPSS 313.

Reclaimed Asphalt Pavement (RAP) means as defined in OPSS 313.

Target Density means the average bulk relative density for each subplot established according to LS-297, and used to determine the per cent compaction.

335.04 DESIGN AND SUBMISSION REQUIREMENTS

335.04.01 Design Requirements

For mix design purposes, prior to commencing the work, the Contractor shall obtain samples that are representative of the material that is produced during the milling operation. These samples shall be used to establish the design rate of expanded asphalt as a percent by mass of the RAP. The mix design shall meet the following requirements:

- a) The design rate of the expanded asphalt shall be a minimum of 1.0%.
- b) The dry tensile strength shall be a minimum of 225 kPa and the wet tensile strength shall be a minimum of 100 kPa.

The mix design shall be carried out according to the Wirtgen Cold Recycling Technology manual using briquettes produced according to LS-297. Mix design shall be completed by a laboratory with Canadian Council of Independent Laboratories (CCIL) Type A certification or equivalent equipped to carry out expanded asphalt mix designs. When the existing pavement significantly changes composition, a separate mix design shall be completed.

Each mix design shall include the following:

- a) Information on the grade, manufacturer, and supplier of the PGAC.
- b) The percent by mass of expanded asphalt in the CIREAM, referred to as the design rate, and all calculations performed to determine the design rate of expanded asphalt.
- c) The recommended PGAC temperature for foaming, the half-life, the expansion ratio and the percent of water added for foaming.
- d) The optimum moisture content and the mix design bulk relative density.
- e) The dry tensile strength, the wet tensile strength, and the tensile strength ratio.
- f) The amount of water to be added to the mix.
- g) Maximum field rate adjustment allowed to the design rate without adverse effects to the mix properties.
- h) Recovered penetration for the binder of the existing pavement according to LS-200.
- i) Type, source and quantity of active filler, if required.

335.04.02 Submission Requirements

A copy of the mix design shall be submitted to the Contract Administrator a minimum of 7 Business Days prior to the start of CIREAM operations. Within 4 Business Days commencing after the day of delivery of all required documents for the mix design, the Contract Administrator shall provide written confirmation of receipt of the submitted mix design documents or of any non-conformance to the contract requirements.

Confirmation of receipt of the mix design documents does not constitute any guarantee that the mix can be produced or constructed or both to Contract requirements, and does not relieve the Contractor of the responsibility for ensuring the specified quality of Materials and workmanship.

A new mix design shall be submitted when the expanded asphalt design rate is adjusted by greater than 0.20%. Separate or new mix designs shall be submitted if the composition or layer thicknesses of the existing pavement changes significantly. Where more than one mix design is required, the area for which each mix design is to be used shall be clearly identified.

335.05 MATERIALS

335.05.01 Reclaimed Asphalt Pavement

RAP material shall be 100% passing the 37.5 mm sieve, and 95% to 100% passing the 26.5 mm sieve after processing, and shall be measured based on air dried gradation according to the coarse sieving operation of LS-602.

335.05.02 Performance Graded Asphalt Cement

PGAC shall be according to OPSS 1101. The table of Additional Testing Requirements and Acceptance Criteria for PGAC Grades shall not apply. PGAC shall be selected with performance properties meeting the design maximum pavement temperature of 52 °C and the minimum pavement temperature of -28 °C at a minimum, and the selected PGAC shall have suitable expansion characteristics.

335.05.03 Water

Water shall be clean and free from oil, acid, alkali, organic matter, or other deleterious substances.

335.05.04 Active Filler

If required by the mix design, active filler shall be incorporated into the reclaimed existing asphalt pavement at the application rate determined in the mix design.

When used as active filler, Portland cement shall be according to OPSS 1301. Not more than 1% by mass of Portland cement shall be added to the mix.

335.06 EQUIPMENT

335.06.01 Recycling Train

The recycling train shall include the following:

- a) A self-propelled cold milling unit with a cutting drum capable of reclaiming a full lane width of asphalt pavement to the depth specified in the Contract Documents in one pass.
- b) A screening and sizing unit capable of processing the RAP.
- c) An aggregate feed system that measures and regulates the mass of RAP being added into the mixing unit prior to the addition of the expanded asphalt. The scale shall be calibrated to the manufacturer's tolerance prior to the start of the work and when requested by the Contract Administrator.
- d) An asphalt cement expansion system capable of producing optimum expansion and an injection system capable of injecting and blending expanded asphalt uniformly throughout the reclaimed material.
- e) A system to control and regulate the application of expanded asphalt in relation to the mass of RAP being processed within a tolerance of $\pm 3.0\%$ by volume of asphalt cement.
- f) A mixing unit capable of producing a uniform and thoroughly blended CIREAM.

335.06.02 Placing Equipment

A mechanical paver capable of spreading the mix evenly in front of the screed in one continuous pass to the specified crossfall and grade shall be used to place the CIREAM. The paver shall be equipped with distributing augers for the full width to be paved. The paver shall have a vibratory screed capable of vibrating the full width of mix placed.

335.06.03 Compaction Equipment

Compaction equipment shall be selected to achieve the required compaction.

335.06.04 Straight Edge

The straight edge shall be 3 m in length, metal, and have a level recessed in its upper edge parallel to the lower edge.

335.06.05 Pilot Vehicle

Pilot vehicles used to control traffic shall be according to OTM, Book 7.

335.07 CONSTRUCTION

335.07.01 General

HMA pavement in areas inaccessible to the reclaiming equipment shall be removed and replaced with acceptable binder course HMA. The HMA shall be placed to the CIREAM depth specified in the Contract Documents in compacted lift thicknesses between 40 and 75 mm in depth.

The overlap between successive passes of the recycling train shall be a minimum 100 mm.

335.07.03 Operational Constraints

Cold in-place recycled expanded asphalt mix (CIREAM) shall not be placed after September 1st without the written approval from the Contract Administrator.

The work shall be carried out when the roadway is clean and free of standing water. Cold in-place recycled expanded asphalt mix shall not proceed during periods of rain or when the surface is in a saturated condition.

All traffic, including construction traffic, shall be kept off the freshly placed CIREAM mat until it is able to carry traffic without damage. Any damage to the CIREAM mat shall be repaired.

The wearing surface shall not be placed on the CIREAM mat until the following requirements have been met:

- a) The CIREAM mat has been opened to traffic and allowed to cure for a minimum of 3 Days.
- b) The specified tensile strength has been achieved according to the Quality Assurance section.
- c) The specified density has been achieved according to the Compaction subsection.
- d) All defective areas in the CIREAM mat have been repaired to the satisfaction of the Contract Administrator.

The wearing surface shall be placed within 30 Days of placing the CIREAM mat. The 30 Day requirement may be waived by the Contract Administrator if the CIREAM does not meet the requirements of this specification and is subject to repair.

335.07.03 Cold In-Place Recycling Expanded Asphalt Trial Section

Prior to carrying out CIREAM, the ability to successfully carry out CIREAM according to this specification shall be demonstrated to the Contract Administrator by placing a trial section within the Contract limits.

In lieu of a trial section, the Contract Administrator may accept evidence that the ability to successfully mix, handle, place, and compact CIREAM with the same equipment, placing crew, and methodology to

meet the Contract requirements for placing CIREAM has been demonstrated on any Contract within the last 12 months.

The trial section shall be one lane width and 500 m in length. The location of the trial section shall be proposed to the Contract Administrator for approval. A minimum of 48 hours notice shall be given to the Contract Administrator prior to placing the trial section.

The Contract Administrator shall allow the CIREAM work to continue based on an acceptable visual assessment of the trial according to the requirements of the Surface Appearance subsection. When the CIREAM is rejected by visual assessment, the trial sections shall be repaired or removed and replaced until the CIREAM meets the requirements of the Surface Appearance subsection.

335.07.04 Surface Preparation

When specified in the Contract Documents, milling prior to CIREAM work shall be carried out to achieve the specified crossfall and grade.

All deleterious and loose milled material shall be removed from the milled surfaces, and longitudinal and transverse joints after reclaiming operations are completed and before placing CIREAM.

All existing crack sealant shall be removed and disposed of prior to CIREAM reclaiming operations.

335.07.05 Mixing

The expanded asphalt shall be added at the design rate. The rate of addition of expanded asphalt shall be field adjusted as required to within 0.20% of the design rate and mixed to produce a uniformly coated CIREAM that can be compacted to the specified density. The expanded asphalt added shall not be less than 1.0%.

335.07.06 Compaction

The CIREAM shall be compacted according to the requirements of the Acceptance Criteria for Compaction subsection.

335.07.07 Surface Appearance

The compacted CIREAM mat shall be smooth and constructed to the crossfall and grade specified in the Contract Documents. The surface of the CIREAM mat shall be of uniform texture and free of segregation, raveling, rutting, longitudinal streaks, flushing, fat spots, oil spills, roller marks, and other defects.

335.07.08 Traffic Control with Moving Vehicles

Traffic shall be controlled with moving vehicles according to OTM, Book 7.

The moving vehicles shall guide one-way traffic through or around construction. The maximum speed of the moving vehicles shall be 30 km/h. Traffic control with moving vehicles shall be maintained until such time as the CIREAM mat is able to carry traffic without damage.

335.07.09 Management of Excess Material

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

335.08 QUALITY ASSURANCE

335.08.01 General

Acceptance of the CIREAM shall be based on the following criteria:

- a) Surface Appearance
- b) Surface Tolerance
- c) Compaction
- d) Tensile Strength
- e) RAP Gradation

Work that does not meet the acceptance criteria shall be repaired according to the Repairing and Re-Evaluating subsection.

335.08.02 Sampling

335.08.02.01 Lot Size

The Contract Administrator shall determine the size and location of the lots and sublots after discussion with the Contractor and before CIREAM production starts. A lot shall typically represent 25,000 m² with 5 equal sublots of 5,000 m² in size.

335.08.02.02 Cold In-Place Recycled Expanded Asphalt Mix Samples

Samples of CIREAM material shall be packaged in non-absorptive materials to protect sample integrity and sealed in waterproof containers. Samples shall be transported in a manner that avoids stacking and extreme temperatures.

335.08.02.02.01 Loose Samples

After placement and prior to compaction, the Contractor shall obtain one 15 kg sample of the CIREAM from each subplot, taken at random locations as directed by the Contract Administrator. The samples to be tested for acceptance of CIREAM shall be used to test for dry tensile strength and wet tensile strength according to LS-297.

For the purpose of determining the RAP gradation, another 30 kg sample of CIREAM samples shall be taken from each of two randomly selected sublots for every lot.

335.08.02.02.02 Slabs

Prior to the planned overlay of the CIREAM mat, two slab samples of the CIREAM material shall be obtained from each subplot. The two slab samples shall be located side-by-side and taken at random locations as directed by the Contract Administrator. Each slab samples shall be dry cut 150 x 150 mm and removed intact from the CIREAM mat.

One slab sample shall be used to test for bulk relative density and the other slab sample shall be used to test for moisture content for the purpose of moisture adjustment according to LS-306.

Additional slab samples for QA acceptance tests shall only be taken after the Contractor has carried out remedial work to improve compaction in the rejected subplot. The Contractor shall be charged the cost of additional tests.

335.08.02.03 Performance Graded Asphalt Cement

Samples of PGAC to be used in the mix shall be taken from the storage tank at the terminal according to the Tank Tap Method specified in AASHTO T40-02 and the terminal's health and safety plan in the presence of the Contract Administrator at a frequency of three sets of samples per Contract for PGAC providing to three different lots. Each set of samples shall be a minimum of 2 full one-litre portions. The Contractor's health and safety plan and procedure for sampling shall be reviewed at the pre-pave meeting.

Samples of PGAC used in the mix shall be obtained, properly labelled and identified, and delivered to the designated QA testing laboratory as specified in the Contract Documents.

335.08.03 Acceptance Criteria

335.08.03.01 Surface Appearance

Surface appearance shall be assessed by the Contract Administrator based on visual surveys after the CIREAM mat has been opened to traffic. The finished CIREAM surface shall have a uniformly smooth texture and shall meet the surface appearance requirements of ravelling, segregation and rutting as specified in Table 1 prior to placement of HMA overlay.

335.08.03.02 Surface Tolerance

The surface tolerance of any CIREAM surface shall be such that when tested with a 3 m straight edge placed anywhere on the CIREAM surface, except across the crown, and in any direction on the surface, there shall not be a gap between the bottom of the straight edge and the surface of the CIREAM greater than 6 mm.

335.08.03.03 Compaction

The compaction of the CIREAM mix shall be calculated for each subplot from the bulk relative density determined from slab samples according to LS-306 or ASTM D-6752 and the target density as follows:

Compaction = (bulk relative density of the slab sample / target density) x 100%

where the target density to be used for acceptance purposes shall be calculated for each subplot by averaging the densities of the six (6) compacted specimens produced for indirect tensile strength testing according to LS-297.

Each lot of CIREAM shall be compacted to a minimum mean of 96.0% of the target density established for the mix, with no individual subplot bulk relative density result falling below 95.0% of the target density. CIREAM that is not compacted to the required density shall be deemed rejectable.

335.08.03.04 Tensile Strength of Cold In-Place Recycled Expanded Asphalt Mix

Acceptance of the CIREAM shall be based on dry tensile strength and wet tensile strength.

Samples of CIREAM shall be tested for acceptance purposes according to LS-297.

Dry tensile strength requirements for the lot are met when:

- a) The mean dry tensile strength of the lot is equal to or greater than 225 kPa; and
- b) No individual subplot dry tensile strength is less than 200 kPa.

Wet tensile strength requirements for the lot are met when:

- a) The mean wet tensile strength of the lot is equal to or greater than 100 kPa; and
- b) No individual subplot wet tensile strength is less than 75 kPa.

CIREAM that does not meet the above dry tensile strength and wet tensile strength requirements shall be deemed rejectable.

335.08.03.05 Reclaimed Asphalt Pavement Gradation

If the RAP does not meet the gradation requirements, the Contractor shall submit an action plan of remediation to the Contract Administrator for approval within 2 Business Days after the delivery of the QA testing results.

335.08.04 Repairing and Re-Evaluating

CIREAM that is rejectable based on the Acceptance Criteria subsection shall be repaired according to the requirements specified in Table 1.

Repairs shall be for the full lane width. For repairs due to the surface appearance defects, the minimum repair length shall be sufficient for the repair to be carried out by the recycling train, or by the paving equipment, whichever is applicable. For other repairs based on the lot and subplot acceptance, the minimum length shall follow the Repairing and Re-Evaluating clause of OPSS 313 and to the depth specified in Table 1.

The HMA required to repair unacceptable CIREAM shall be placed in compacted lift thicknesses between 40 and 75 mm. The HMA mix type and design used for repairs shall be approved by the Contract Administrator and shall meet the acceptance requirements for the HMA specified elsewhere in the Contract Documents.

All repairs will be re-evaluated and retested according to the Acceptance Criteria subsection.

335.09 MEASUREMENT FOR PAYMENT

335.09.01 Actual Measurement

335.09.01.01 Cold In-Place Recycled Expanded Asphalt Mix

Measurement of CIREAM placed shall be by area in square metres.

335.09.02 Plan Quantity Measurement

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

335.10 BASIS OF PAYMENT

335.10.01 Cold In-Place Recycled Expanded Asphalt Mix - Item

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

The addition of active filler or other additives to the mix, including any expanded asphalt that is required due to the additives, shall be at no extra cost to the Owner.

HMA required to replace unacceptable CIREAM material shall be at no extra cost to the Owner.

PGAC shall be included in the CIREAM item.

Repair of an unacceptable CIREAM mat shall be carried out at no extra cost to the Owner.

HMA placed in areas inaccessible to the reclaiming equipment shall be included in the CIREAM item.

Repair of areas of CIREAM damaged by traffic shall be completed at no extra cost to the Owner.

Repair, removal, or replacement of an unacceptable trial section shall be completed at no extra cost to the Owner.

TABLE 1
Acceptance Criteria and Repair Requirements for CIREAM

Acceptance Criteria	Defect Type	Severity / Criteria	Acceptable / Rejectable	Repair Requirements
Surface Appearance	Ravelling/Coarse Aggregate Loss (Note 1)	Very Slight to Slight	Acceptable	No action required.
		Moderate to Severe	Rejectable	Mill 50 mm and replace with an acceptable binder course HMA (Note 2).
		Very Severe	Rejectable	Remove CIREAM to full depth and replace with an acceptable binder course HMA (Note 2).
	Segregation (Note 1)	Slight to Medium	Acceptable	No action required.
		Severe	Rejectable	Mill 50 mm and replace with an acceptable binder course HMA (Note 2).
	Rutting (Note 1)	Very Slight to Slight	Acceptable	No action required.
		Moderate to Severe	Rejectable	Mill 50 mm and replace with an acceptable binder course HMA (Note 2).
		Very Severe	Rejectable	Remove CIREAM to full depth and replace with an acceptable binder course HMA (Note 2).
Surface Tolerance	Non-conformance for surface tolerance as per the Surface Tolerance subsection of the Acceptance Criteria.	> 6 mm based on 3 m straightedge measurement	Rejectable	All deficient areas shall be re-profiled by milling or padded with the same hot mix type to be used in the overlying hot mix lift.
Compaction	Non-conformance for Compaction as per the Compaction subsection of the Acceptance Criteria.	< 96% for Compaction of Lot's Mean; and < 95% for Compaction of Individual Sublot	Rejectable	For rejected sublots, or sublots within the corresponding rejected lot: 1) Recompect the CIREAM mat, if required, with reheating process, or 2) Reprocess with a recycling train (Note 2), or 3) Remove CIREAM material to full depth and replace with an acceptable binder course HMA.
Tensile Strength	Non-conformance for Tensile Strength as per the Tensile Strength of Cold In-place Recycled Expanded Asphalt Mix subsection of the Acceptance Criteria.	For Dry Tensile Strength: < 225 KPa for Lot's Mean; and < 200 KPa for Individual Sublot. For Wet Tensile Strength: < 100 KPa for Lot's Mean; and < 75 KPa for Individual Sublot.	Rejectable	Remove CIREAM to full depth in the lot or sublot represented by the test and replace with an acceptable binder course HMA (Note 2).
Notes: 1) Defect and severity definitions according to SP-027. 2) Reprocessing with a recycling train may be considered as a repair method, upon submission of a proposal by the Contractor and approved by the Contract Administrator.				

Appendix 335-A, November 2015
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

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

Designer Action/Considerations

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR THE GRINDING OF CENTRELINE AND SHOULDER RUMBLE STRIPS IN ASPHALT

TABLE OF CONTENTS

342.01	SCOPE
342.02	REFERENCES
342.03	DEFINITIONS – Not Used
342.04	DESIGN AND SUBMISSION REQUIREMENTS – Not Used
342.05	MATERIALS – Not Used
342.06	EQUIPMENT
342.07	CONSTRUCTION
342.08	QUALITY ASSURANCE – Not Used
342.09	MEASUREMENT FOR PAYMENT
342.10	BASIS OF PAYMENT

APPENDICES

342 -A	Commentary
---------------	-------------------

342.01 SCOPE

This specification covers the requirements for the installation of centreline rumble strips (CRS) into the surface course of asphalt pavement, and the grinding of shoulder rumble strips (SRS) into the surface course of fully or partially paved asphalt shoulders.

342.01.01 Specification Significance and Use

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

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

342.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

342.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 313	Hot Mix Asphalt – End Result
OPSS 510	Removal
OPSS 710	Pavement Marking

342.06 EQUIPMENT

The construction equipment shall employ a rotary type cutting head capable of installing rumble strips with a smooth surface to the lines and dimensions as specified in the Contract Documents.

342.07 CONSTRUCTION

342.07.01 General

Centreline rumble strips (CRS) shall be installed at the centreline of the highway as specified in the Contract Documents.

Shoulder rumble strips (SRS) shall be installed at the partially paved asphalt shoulder or fully paved asphalt shoulder as specified in the Contract Documents.

The pavement surface shall be cleaned and all debris shall be disposed of as specified elsewhere in the Contract Documents.

342.07.02 Placement

Centreline rumble strips and SRS shall not be placed within 200 mm of routed and filled transverse joints.

Centreline rumble strips shall be installed prior to the final pavement markings being placed.

Shoulder rumble strips shall be installed after the final pavement markings have been placed. Any damage to the final pavement markings shall be repaired according to OPSS 710.

Where SRS are installed in conjunction with a bicycle buffer zone, the SRS shall be installed prior to the placement of the outer pavement marking edge line.

342.07.03 Tolerances

Tolerances for the width and depth of each rumble strip groove shall be as specified in the Contract Documents. If any one of these tolerances is exceeded in more than two grooves within a one metre length section, the section shall be rejected.

Rejected sections shall be repaired or assessed a payment reduction as directed by the Contract Administrator.

Rejected sections shall be repaired by partial depth asphalt removal according to OPSS 510, replacement of the hot mix asphalt according to OPSS 313, the reinstallation of rumble strips according to this specification, and reinstatement of damaged pavement markings according to OPSS 710. The depth of the partial depth removal shall be 50 mm and the width shall be 500 mm centred over the rumble strip. However, when this will result in a narrow remaining width of asphalt pavement on either side that is less than 300 mm, the removal width shall be extended to include the narrow width of asphalt pavement.

342.09 MEASUREMENT FOR PAYMENT

342.09.01 Actual Measurement

342.09.01.01 Shoulder Rumble Strips - Asphalt Centreline Rumble Strips – Asphalt Shoulder Rumble Strips for Bicycle Buffer Zone - Asphalt

Measurement of rumble strips shall be by horizontal length in metres in which the CRS or SRS have been placed.

342.09.02 Plan Quantity Measurement

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

342.10 BASIS OF PAYMENT

**342.10.01 Shoulder Rumble Strips - Asphalt – Item
Centreline Rumble Strips- Asphalt - Item
Shoulder Rumble Strips for Bicycle Buffer Zone – Asphalt - Item**

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

When the Contract contains separate items for work required by this specification, payment shall be at the Contract prices and according to the specifications for such work.

Appendix 342-A, November 2015
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

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

Designer Action/Considerations

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR TRENCHING, BACKFILLING, AND COMPACTING

TABLE OF CONTENTS

401.01	SCOPE
401.02	REFERENCES
401.03	DEFINITIONS
401.04	DESIGN AND SUBMISSION REQUIREMENTS - Not Used
401.05	MATERIALS
401.06	EQUIPMENT - Not Used
401.07	CONSTRUCTION
401.08	QUALITY ASSURANCE - Not Used
401.09	MEASUREMENT FOR PAYMENT
401.10	BASIS OF PAYMENT

APPENDICES

401-A	Commentary
--------------	-------------------

401.01 SCOPE

This specification covers the requirements for excavating, backfilling, and compacting trenches for the installation of sanitary and storm pipe sewers; pipe culverts and end sections; pipe subdrains; forcemains and associated appurtenances; watermain and associated appurtenances; and other underground Utilities.

401.01.01 Specification Significance and Use

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

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

401.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

401.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 206	Grading
OPSS 403	Rock Excavation for Pipelines, Utilities, and Associated Structures in Open Cut
OPSS 404	Support Systems
OPSS 412	Sewage Forcemain Installation in Open Cut
OPSS 441	Watermain Installation in Open Cut
OPSS 490	Site Preparation for Pipelines, Utilities, and Associated Structures
OPSS 491	Preservation, Protection, and Reconstruction of Existing Facilities
OPSS 492	Site Restoration Following Installation of Pipelines, Utilities, and Associated Structures
OPSS 501	Compacting
OPSS 510	Removal
OPSS 517	Dewatering of Pipeline, Utility, and Associated Structure Excavation
OPSS 539	Temporary Protection Systems
OPSS 902	Excavating and Backfilling - Structures

Ontario Provincial Standard Specifications, Material

OPSS 1010	Aggregates - Base, Subbase, Select Subgrade, and Backfill Material
OPSS 1359	Unshrinkable Backfill

Provincial Statute

Occupational Health and Safety Act

R.S.O. 1990, c. O.1, as amended

Ontario Regulations 213/91 - Regulations for Construction Projects, as amended

401.03 DEFINITIONS

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

Additional Excavation means all excavation ordered in writing by the Contract Administrator beyond excavation specified in the Contract Documents.

Associated Appurtenances means as defined in OPSS 412 and OPSS 441.

Backfilling means the operation of filling the trench with bedding, cover, and backfill material or embedment and backfill material.

Backfill Material means fill material used above the embedment or cover material and below the lower of the subgrade or finished grade or the original ground.

Bedding Class means a classification system that defines the depth of the bedding material.

Bedding Material means material as it relates to rigid pipe, from the bottom of the trench to the bottom of the cover.

Cover Material means the material placed from the top of the bedding to the bottom of the backfill for rigid pipe.

Embedment Material means material as it relates to flexible pipe, from the bottom of the trench to the bottom of the backfill.

Excavation, Earth and Rock means the excavation classified as earth and rock according to OPSS 206.

Flexible Pipe means pipe that can deflect 2% or more without cracking such as polyvinyl chloride, polyethylene, or steel pipe.

Imported Material means material obtained from a source other than the Working Area.

Native Material means the material removed to form an excavation within the Working Area for return to the same or other excavation.

Pipe means sanitary or storm pipe sewers, watermains, forcemains, pipe culverts, and subdrains.

Rigid Pipe means pipe that cannot deflect more than 2% without cracking such as concrete pipe.

Trench means as defined in Ontario Regulations 213/91.

Trenching means the earth or rock excavation required to construct a trench in which to install pipes and their associated appurtenances.

Trench Width means the horizontal distance between the trench walls as measured at the bedding grade.

Unshrinkable Fill means as defined in OPSS 1359.

401.05 MATERIALS

401.05.01 Embedment Material

Embedment material shall be one of the following, as specified in the Contract Documents:

- a) Granular A.
- b) Granular B, Type I, II, or III, with 100% passing the 26.5 mm sieve.
- c) Unshrinkable fill.

401.05.02 Bedding Material

Bedding material shall be one of the following, as specified in the Contract Documents:

- a) Granular A.
- b) Granular B, Type I, II, or III, with 100% passing the 26.5 mm sieve.
- c) Unshrinkable fill.

401.05.03 Cover Material

Cover material shall be one of the following, as specified in the Contract Documents:

- a) Granular A.
- b) Granular B, Type I, II, or III, with 100% passing the 26.5 mm sieve.
- c) Native material.

401.05.04 Granular Material

Granular material shall be according to OPSS 1010.

401.05.05 Backfill Material

401.05.05.01 General

Backfill material shall be one of the following, as specified in the Contract Documents:

- a) Granular A.
- b) Granular B, Type I, II, or III.
- c) Unshrinkable fill.
- d) Native material.

401.05.05.02 Native and Imported Material

Native and imported material shall be approved by the Contract Administrator. All material shall be free from frozen lumps, cinders, ashes, refuse, vegetable or organic matter, rocks and boulders over 150 mm in any dimension, and other deleterious material.

401.05.06 Unshrinkable Fill

Unshrinkable fill shall be according to OPSS 1359.

401.07 CONSTRUCTION

401.07.01 General

Trenches shall be stable and dry, unless designated as subaqueous work.

401.07.02 Site Preparation

Site preparation shall be according to OPSS 490.

401.07.03 Preservation and Protection of Existing Facilities

Preservation and protection of existing facilities shall be according to OPSS 491.

401.07.04 Removals

Removals shall be according to OPSS 510.

401.07.05 Dewatering

Dewatering shall be according to OPSS 517 for placement of pipe or to OPSS 902 for placement of structure.

401.07.06 Support Systems

Support systems shall be according to OPSS 404.

401.07.07 Temporary Protection Systems

The construction of all temporary protection systems shall be according to OPSS 539. When the stability, safety, or function of an existing roadway, railway, other works, or proposed works may be impaired due to the method of operation, appropriate protection shall be provided. Protection may include sheathing, shoring, and the driving of piles, when necessary.

401.07.08 Removal of Frozen Ground

Written permission shall be obtained from the Contract Administrator prior to starting any excavation in frozen ground. The method used for removal of frozen ground shall not cause damage to adjacent structures or Utilities.

401.07.09 Trenching

Trenches shall be excavated to the lines, grades, and dimensions specified in the Contract Documents. The width of the trench at the bottom shall not exceed the width at the top.

Trenching for pipe culverts shall include the excavation for frost tapers and end sections.

No more than 15 m of trench shall be open in advance of the completed pipe system.

The Contract Administrator shall be notified immediately if the bottom of the trench appears to give an unsuitable foundation.

When installing rigid pipe, if the trench is excavated wider than the allowable width without authorization, the Contract Administrator may require the use of a stronger pipe or a higher class of bedding or both.

If the trench depth is excavated beyond the limits of the required excavation without the Contract Administrator's authorization, granular material shall be placed and compacted in the trench to reinstate the required trench limits prior to backfilling the trench as specified in the Contract Documents. Alternatively, another structurally accepted design shall be provided by adjusting the limits of the excavation prior to backfilling.

Rock excavation for trenches shall be according to OPSS 403.

401.07.10 Backfilling and Compacting

401.07.10.01 General

The diameter or the span and rise of flexible pipes shall not vary from the manufactured dimensions by more than 5% during cover and backfill placing operations.

Pipe installation and backfilling shall be completed prior to the start of subbase and base course construction over the pipe location.

Compacting of embedment, bedding, cover, and backfill materials during pipe installation shall be according to OPSS 501.

Prior to allowing the movement of any construction equipment or vehicular traffic over the buried infrastructure, the depth of backfill shall be sufficient enough to protect the buried infrastructure from damage.

401.07.10.02 Embedment

Placement of embedment material shall be as described in the Bedding and Cover clauses.

401.07.10.03 Bedding

Pipe bedding shall be of the class specified in the Contract Documents.

The surface upon which the pipe is to be laid shall be true to grade and alignment.

The pipe bedding shall be shaped to the dimensions specified in the Contract Documents. When bell and spigot pipe is to be laid, recesses shall be shaped to receive the bells.

Bedding material placed in the haunches shall be compacted prior to continued placement of cover material.

Bedding material shall be placed in uniform layers not exceeding 200 mm in thickness, loose measurement, and each layer shall be compacted according to OPSS 501 before a subsequent layer is placed.

Bedding material shall be placed on each side of the pipe and shall be completed simultaneously. At no time shall the levels on each side differ by more than the 200 mm uncompacted layer.

401.07.10.04 Cover

Cover material shall be placed so that damage to or movement of the pipe is avoided.

Cover material shall be placed in uniform layers not exceeding 200 mm in thickness, loose measurement,

and each layer shall be compacted according to OPSS 501 before a subsequent layer is placed.

Cover material shall be placed on each side of the pipe and shall be completed simultaneously. At no time shall the levels on each side differ by more than the 200 mm uncompacted layer.

401.07.10.05 Backfill

Backfill material shall be placed in uniform layers not exceeding 300 mm in thickness, loose measurement, for the full width of the trench and each layer shall be compacted according to OPSS 501 before a subsequent layer is placed.

Backfill material shall be placed to a minimum depth of 900 mm above the crown of the pipe before power operated tractors or rolling equipment shall be used for compacting. Uniform layers of backfill material exceeding 300 mm in thickness may be placed with the approval of the Contract Administrator.

When the Contract specifies native backfill material, acceptable earth backfill material may be substituted with the approval of the Contract Administrator. In areas within the roadway, for a depth equal to the frost treatment, the earth backfill material shall have frost susceptible characteristics similar to the adjacent material.

401.07.11 Additional Trenching, Backfilling, and Compacting

Additional trenching, backfilling, and compacting shall be as described in the Trenching and Backfilling and Compacting subsections.

Unsuitable material shall be excavated and the resulting excavation shall be backfilled and compacted to obtain a suitable foundation.

401.07.12 Site Restoration

Site restoration shall be according to OPSS 492.

401.07.13 Management of Excess Material

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

401.09 MEASUREMENT FOR PAYMENT

401.09.01 Actual Measurement

401.09.01.01 Additional Trenching, Backfilling, and Compacting

Additional trenching, backfilling, and compacting shall be based on the volume of the additional excavation measured in cubic metres prior to installation of the pipe.

The volume of the excavation that is in addition to the limits specified in the Contract Documents shall be determined.

401.10 BASIS OF PAYMENT

401.10.01 Trenching, Backfilling, and Compacting

Payment at the Contract price for the appropriate tender items for the installation of sanitary and storm pipe sewers, pipe culverts and end sections, subdrains, forcemains and associated appurtenances,

watermains and associated appurtenances, and other underground Utilities shall be full compensation for all labour, Equipment, and Material to do the work.

When the Contract contains separate items for work required by this specification, payment shall be at the Contract prices and according to the specifications for such work.

Any expenses for remedial work resulting from unauthorized over-excavation of the trench width and depth shall be borne by the Contractor.

When native material is deemed unsuitable for backfill for reasons other than those attributed to the Contractor's mode of operation, any additional work done to provide acceptable backfill beyond the work herein specified shall be administered as a Change in the Work.

401.10.02 Additional Trenching, Backfilling, and Compacting - Item

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

401.10.03 Rock Excavation for Trenches

Payment for rock excavation for trenches shall be according to OPSS 403.

Appendix 401-A, November 2015
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

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

Designer Action/Considerations

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR PIPE SEWER INSTALLATION IN OPEN CUT

TABLE OF CONTENTS

410.01	SCOPE
410.02	REFERENCES
410.03	DEFINITIONS
410.04	DESIGN AND SUBMISSION REQUIREMENTS - Not Used
410.05	MATERIALS
410.06	EQUIPMENT - Not Used
410.07	CONSTRUCTION
410.08	QUALITY ASSURANCE - Not Used
410.09	MEASUREMENT FOR PAYMENT
410.10	BASIS OF PAYMENT

APPENDICES

410-A	Commentary
--------------	-------------------

410.01 SCOPE

This specification covers the requirements for the installation and inspection of storm and sanitary pipe sewers, laterals, service connections, and concrete appurtenances in open cut.

410.01.01 Specification Significance and Use

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

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

410.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

410.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 206	Grading
OPSS 401	Trenching, Backfilling, and Compacting
OPSS 404	Support Systems
OPSS 407	Maintenance Hole, Catch Basin, Ditch Inlet, and Valve Chamber Installation
OPSS 409	Closed-Circuit Television Inspection of Pipelines
OPSS 490	Site Preparation for Pipelines, Utilities, and Associated Structures
OPSS 491	Preservation, Protection, and Reconstruction of Existing Facilities
OPSS 492	Site Restoration Following Installation of Pipelines, Utilities, and Associated Structures
OPSS 510	Removal
OPSS 517	Dewatering of Pipeline, Utility, and Associated Structure Excavation
OPSS 539	Temporary Protection Systems
OPSS 904	Concrete Structures
OPSS 905	Steel Reinforcement for Concrete

Ontario Provincial Standard Specifications, Material

OPSS 1004	Aggregates - Miscellaneous
OPSS 1205	Clay Seal
OPSS 1301	Cementing Materials
OPSS 1302	Water
OPSS 1350	Concrete - Materials and Production
OPSS 1440	Steel Reinforcement for Concrete
OPSS 1801	Corrugated Steel Pipe Products
OPSS 1820	Circular Concrete Pipe
OPSS 1840	Non-Pressure Polyethylene Plastic Pipe Products
OPSS 1841	Non-Pressure Polyvinyl Chloride (PVC) Pipe Products

OPSS 1843 Non-Pressure Polypropylene (PP) Plastic Pipe Products
OPSS 1860 Geotextiles

CSA Standards

B182.1-11 Plastic Drain and Sewer Pipe and Pipe Fittings
[Part of B1800-11, Plastic Non-Pressure Pipe Compendium]
G401 Corrugated Steel Pipe Products

ASTM International

B 746 Corrugated Aluminum Alloy Structural Plate for Field-Bolted Pipe, Pipe-Arches, and Arches;
C 507-12 Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe

Other

WRC Manual of Sewer Condition Classification (MSCC), Fourth and/or Third Edition

410.03 DEFINITIONS

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

Acceptable Pipe Condition Status means the assessment designation assigned to an installed gravity pipe installation that has no deficiencies.

Aluminum Alloy means a material made with two or more metals in which aluminum is the predominant metal.

Backfilling means the operation of filling the trench with bedding, cover, and backfill material or embedment and backfill material.

CCTV means closed-circuit television used to inspect a gravity pipe installation.

Certification Body means an independent 3rd party agency accredited by the Standards Council of Canada that has the qualifications, skills, and expertise required to confirm that a pipe manufacturer produces pipe products to the quality and requirements of an accepted standard and that has the mandate to certify the pipe products produced.

Certified means pipe products that have been marked with a certification body's logo confirming that the production of the pipe product is in accordance with the quality and requirements of the manufacturing standard.

Concrete Appurtenances means concrete head walls, cut-off walls, stiffeners, aprons, collars, and any other concrete fixtures associated with the pipe sewer, excluding concrete bedding or concrete structures specified in the Contract Documents.

Delivered Quality means the pipe products' physical condition upon arrival at the construction site in terms of the extent and degree of dents, scratches, cracks, pipe coating integrity, etc., that appear on the pipe products delivered.

Dimension Ratio means the average specified outside diameter of a pipe divided by the minimum specified wall thickness.

Drainage Structure means a maintenance hole, catch basin, or ditch inlet.

Excavation, Earth and Rock means the excavation classified as earth and rock according to OPSS 206.

Flexible Pipe means pipe that can deflect 2% or more without cracking, such as polyvinyl chloride or polyethylene or steel pipe.

Gravity Pipe Installation means a constructed pipe system conveying surface waters under the influences of gravity only and can be a pipe sewer or a pipe culvert.

Inspection Assessment means evaluating the findings of a post installation inspection and quantifying the pipe condition status of the gravity pipe installation.

Laser Profiler means an instrument that uses a light ring to survey, locate, measure and report profile, deflection and dimensional attributes, including anomalies, in a gravity pipe installation.

Mandrel means an instrument equipped with an odd number of arms that is pulled through a flexible gravity pipe installation to determine deflection anomalies.

NASSCO means the National Association of Sewer Service Companies which certifies inspectors to perform inspection of pipe sewers and culverts and code viewed pipe conditions.

Pipe Class means a pipe's physical material specification, such as load and pressure ratings, wall thickness, protective coatings, corrugation profiles, ring stiffness constants, and reinforcement.

Pipe Condition Coding means the assignment of code designations to pipe attributes such as pipe materials, walls, joints, service connections or any other physical pipe characteristics.

Pipe Condition Status means the designation assigned to the gravity pipe installation based on the assessment of the post installation inspection results.

Pipe Condition Assessment Rating means the final gravity pipe installations' acceptance rating that is given to the pipe based on the evaluation of the final post installation inspection results inclusive of both original and additional test segments from the post installation inspection, referee post installation inspection and follow up repair inspection.

Pipe Run means a section of a pipe sewer between two drainage structures or between a drainage structure and an outlet.

Pipe Sewer means an installation designed for the conveyance of sanitary sewage or storm water using preformed or precast pipe sections, circular or non-circular in cross-section, laid end to end using suitable jointing material and connected by maintenance holes for sanitary pipe sewers and by maintenance holes, catch basins, ditch inlets, or concrete appurtenances for storm pipe sewers.

Pipe Type means a pipe's inner wall design, which can be smooth or corrugated.

Polypropylene Plastic means a material made with virgin polymers in which propylene is essentially the sole monomer.

Post Installation Inspection means quantifying the final installed condition of gravity pipe installations using accepted surveillance and measuring methods.

Reject Pipe Condition Status means the designation assigned to an installed gravity pipe installation, pipe lengths, pipe fittings and/or pipe service connections that have deficiencies that cannot be repaired to maintain the structural integrity or design service life of the gravity pipe installation or has certain measurable pipe attributes that are beyond Owner acceptance limits.

Repair Pipe Condition Status means the designation assigned to an installed gravity pipe installation, pipe lengths, pipe fittings and/or pipe service connections that have deficiencies that can be repaired to maintain the structural integrity and design service life of the gravity pipe installation.

Repaired Pipe Condition Status means the designation assigned to installed gravity pipe installations, pipe lengths, pipe fittings and/or pipe service connections with a Repair Pipe Condition Status that have been repaired using acceptable intrusive repair measures.

Replacing means the removal of any gravity pipe installations, pipe lengths, pipe fittings and/or pipe service connections and reinstalling the gravity pipe installation, pipe lengths, pipe fittings and/or pipe service connections to contract specifications.

Service Connection means the pipe used to convey sanitary sewage or storm water from the property line to the main sanitary or storm pipe sewer respectively.

Threshold Pipe Condition Status means the designation assigned to an installed gravity pipe installation, pipe lengths, pipe fittings and/or pipe service connections that have certain measurable pipe attributes that are beyond accepted construction limitations but are still within Owner acceptance limits and requires no remediation actions.

Test Segment means an individual sewer pipe run or pipe culvert that has been selected to have a post installation inspection performed on it.

Visual Observation Inspection means coding and describing the profiles, deflection and dimensional features, including anomalies, in a gravity pipe installation using direct human entry into the pipe sewer run or pipe culvert.

Zoom Camera means a stationary video camera fitted with a tele-objective zoom lens and high-powered floodlights and used to inspect a gravity pipe installation.

410.05 MATERIALS

410.05.01 Pipe Materials

410.05.01.01 General

Pipe sewer size, type, and class shall be as specified in the Contract Documents.

Pipe sewer size and class shall be consistent throughout a pipe run as specified in the Contract Documents. Pipe type shall be consistent throughout a pipe sewer as specified in the Contract Documents.

Fittings shall be suitable for and compatible with the pipe type and class for which they will be used.

410.05.01.02 Concrete Pipe

Circular concrete pipe and joints shall be according to OPSS 1820.

Elliptical concrete pipe and joints shall be according to ASTM C 507.

410.05.01.03 Corrugated Steel Pipe Products

Corrugated steel pipe products shall be according to OPSS 1801.

Steel structural plate pipe with polymer coating shall be according to CSA G401.

410.05.01.04 Polyethylene Pipe Products

Polyethylene pipe products shall be according to OPSS 1840.

410.05.01.05 Polyvinyl Chloride Pipe Products

Polyvinyl chloride pipe products shall be according to OPSS 1841.

Polyvinyl chloride service connection pipe shall be according to CSA B182.1 and shall have bell and spigot joints with elastomeric gaskets.

410.05.01.06 Polypropylene Plastic Pipe Products

Polypropylene plastic pipe products shall be according to OPSS 1843.

410.05.01.07 Aluminum Alloy Pipe Products

Corrugated aluminum alloy structural plate pipe products shall be according to ASTM B746.

All corrugated aluminum alloy structural plate pipe products used on the Contract shall be certified and supplied from a manufacturer that produces the corrugated aluminum alloy structural plate pipe products according to ASTM B746. Only products with an accepted certification body logo marking as shown in Figure 1 shall be used.

Inspection, testing, and record keeping for corrugated aluminum alloy structural plate pipe products shall be according to ASTM B746.

Certified corrugated aluminum alloy structural plate pipe shall be marked according to ASTM B746, and shall include as a minimum the logo of the certification body and name of the pipe manufacturer.

When requested by the Owner, a copy of the certificate of compliance issued by the certification body confirming that the manufacturer produces certified corrugated aluminum alloy structural plate pipe products shall be submitted to the Contract Administrator.

The cost of all testing, except that performed in the Owner's laboratory, shall be included in the price.

Where the delivered quality of certified corrugated aluminum alloy structural plate pipe products is deemed to be unacceptable by the Contract Administrator, the products shall be rejected.

410.05.02 Mortar

Mortar for joints shall be composed of one part normal Portland cement and two parts mortar sand, wetted with only sufficient water to make the mixture plastic. The mortar sand shall be according to OPSS 1004, the normal Portland cement shall be according to OPSS 1301, and the water shall be according to OPSS 1302.

410.05.03 Clay Seal

Clay seal material shall be according to OPSS 1205.

410.05.04 Concrete

Concrete for concrete appurtenances shall be according to OPSS 1350 with a nominal minimum 28-Day compressive strength of 30 MPa.

410.05.05 Steel Reinforcement

Steel reinforcement shall be of the size and grade specified in the Contract Documents and shall be according to OPSS 1440.

410.05.06 Geotextile

Geotextile shall be according to OPSS 1860.

410.07 CONSTRUCTION

410.07.01 Site Preparation

Site preparation shall be according to OPSS 490.

410.07.02 Removals

Removals shall be according to OPSS 510.

410.07.03 Preservation and Protection of Existing Facilities

Preservation and protection of existing facilities shall be according to OPSS 491.

410.07.04 Protection Against Floatation

Damage to the pipeline due to floatation shall be prevented during construction and until completion of the work.

410.07.05 Cold Weather Work

All work shall be protected from freezing. Pipes and bedding material shall not be placed on frozen ground.

410.07.06 Transporting, Unloading, Storing, and Handling Pipe

Manufacturer's recommendations for transporting, unloading, storing, and handling of pipe shall be followed.

All pipes, fittings, and gaskets that are unsound or damaged shall be rejected.

410.07.07 Excavation

Excavation for the placement of pipe sewers shall be according to OPSS 401.

410.07.08 Support Systems

Support systems shall be according to OPSS 404.

410.07.09 Dewatering

Dewatering shall be according to OPSS 517.

410.07.10 Protection Systems

The construction of all protection systems shall be according to OPSS 539. When the stability, safety, or function of an existing roadway, railway, other works, or proposed works may be impaired due to the method of operation, such protection as may be required shall be provided. Protection may include sheathing, shoring, and the driving of piles, when necessary, to prevent damage to such works or proposed works.

410.07.11 Backfilling and Compacting

Backfilling and compacting shall be according to OPSS 401.

410.07.12 Pipe Installation

410.07.12.01 General

If a universal dimple coupler or any other coupler does not follow the contour of the flexible pipe sections to be joined, polyethylene gaskets shall then be installed at all joints when such couplers are used. Polyethylene gaskets shall be installed symmetrically about the pipe joint, between the coupler and the pipe, and shall be of sufficient length to equal the circumference of the pipe plus a minimum overlap of 300 mm.

Pipe shall be laid within the alignment and grade tolerances specified in the Contract Documents. When bell and spigot pipe is laid, the bell end of the pipe shall be laid upgrade.

Pipe shall be kept clean and dry as work progresses. The trench shall be kept dry. A removable watertight bulkhead shall be installed at the open end of the last pipe laid whenever work is suspended.

Pipe shall not be laid until the preceding pipe joint has been completed and the pipe is carefully embedded and secured in place.

When the Owner raises or lowers the invert of a pipe sewer by 150 mm or less, it shall not constitute a Change in the Work and no adjustment shall be made to the payment. When the invert of a pipe sewer is raised or lowered by more than 150 mm, it shall constitute a Change in the Work for the full extent of the change from the original grade.

When installing gaskets, all pipe ends shall be thoroughly cleaned. For gaskets requiring field lubrication, a lubricant recommended by the pipe manufacturer shall be used.

When gaskets have been affixed, the pipe shall be handled in a way so that the gasket is not damaged, displaced, or contaminated with foreign matter. Any gasket displaced or contaminated shall be removed, cleaned, and lubricated, if required, and reinstalled before closure of the joint is attempted. When specified in the Contract Documents, nitrile gaskets shall be used.

The pipe shall be properly positioned by means of an appropriate mechanism. Sufficient pressure shall be applied in making the joint to ensure that the joint is in position. Sufficient restraint shall be applied to the line to ensure that joints are held in this position.

Once the pipe has been jointed, a test shall be made with a feeler gauge at intervals around the joint to ensure that the gasket has not been displaced from the spigot groove. If the gasket is found out of position, the joint shall be opened and the gasket placed in its proper position. If necessary, a new gasket shall be installed.

410.07.12.02 Circular Concrete Pipe

All circular concrete pipe joints shall have elastomeric gaskets.

410.07.12.03 Non-Circular Concrete Pipe

Elliptical concrete pipes and joints shall be used for storm pipe sewers only.

All non-circular concrete pipe joints shall be according to the procedures recommended by the manufacturer.

410.07.12.04 Corrugated Steel Pipe Products

Corrugated steel pipe products shall be used for storm pipe sewers only.

Helical corrugated steel pipe without rerolled ends shall be installed so that the helix angle is constant for the total length of the installation. Each pipe section shall be installed next to the previous section so that the lockseam forms a continuous helix. For rerolled ends, the correct fit of the coupling system does not depend on the location of the helical lockseam and corrugation.

Corrugated steel pipe sections shall be joined by means of steel couplers. The couplers shall be installed to lap approximately equal portions of the pipes being connected so that the corrugations or projections of the coupler properly engage the pipe corrugations. As the coupler is being tightened, it shall be tapped with a mallet to take up the slack.

When joint seals are specified in the Contract Documents, they shall be installed immediately prior to the installation of steel couplers.

410.07.12.05 Polyethylene Pipe

Polyethylene pipe shall be jointed by one of the following methods, as recommended by the manufacturer:

- a) Bell and Spigot
- b) Welded Joint
- c) Thermal Fusion Joint
- d) Screw-on Coupler
- e) Split Coupler
- f) Threaded Joint
- g) Mechanical Restrained Joint with Gasket

410.07.12.06 Polyvinyl Chloride Pipe

Polyvinyl chloride pipe shall be jointed, as recommended by the manufacturer, using a bell and spigot joint with an elastomeric gasket.

At the end of a day's work, the last pipe shall be blocked as may be required to prevent movement.

410.07.12.07 Polypropylene Pipe

Polypropylene pipe shall be jointed by means of a bell and spigot joint with elastomeric gasket or a coupler joint as recommended by the manufacturer to satisfy the pipe joint specification.

410.07.12.08 Corrugated Aluminum Alloy Structural Plate Pipe

Corrugated aluminum alloy structural plate pipe shall be jointed by means of bolts as recommended by the manufacturer to satisfy the pipe joint specification.

410.07.13 Service Connections

Service connections to the main pipe sewer shall be made using factory made tees or wyes, strap-on-saddles, or other approved saddles. Factory made tees or wyes shall be used for all service connections when the diameter of the main pipe sewer is:

- a) less than 450 mm; or
- b) less than twice the diameter of the service connection.

Strap-on-saddles shall be installed before laying the pipe.

Holes in the main pipe sewer shall be cut with approved cutters and shall be the minimum diameter required to accept the service connection saddle. If mortar-on saddles are used, the inside of the pipe shall be mortared at the connection.

Service connections shall be plugged at the property line with watertight caps or plugs. Plugs or caps shall be braced sufficiently to withstand test pressures.

When existing service connections shall be connected to new pipe sewers or service connections, proper jointing procedures shall be used.

410.07.14 Marking and Recording Service Connections

A painted temporary location marker consisting of a 50 x 75 mm stake or two short sections of lumber connected by a piece of heavy gauge wire shall be placed at the end of the plugged or capped service connection. The marker shall be placed from 300 mm below the finished grade to a point 300 mm above the plugged end of the service pipe.

A painted surface stake, 50 x 75 x 450 mm long, shall be placed after trench restoration.

Service connections shall not be backfilled until they have been inspected and measurements of location have been taken by the Contract Administrator.

410.07.15 Breaking into Maintenance Holes, Catch Basins, Ditch Inlets, Pipe Culverts, and Pipe Sewers

Openings shall be made as necessary in an existing maintenance hole, catch basin, ditch inlet, pipe culvert, or pipe sewer to install the new pipe sewer and connect it to the structure according to OPSS 407. Benching in existing maintenance holes shall be altered to accommodate the flow in the new pipe sewer system.

When specified in the Contract Documents, the opening for the connection of a subdrain outlet shall be formed by coring. The subdrain outlet pipe shall be sealed into place using non-shrink grout. When specified in the Contract Documents, a 50 mm diameter weep hole shall be cored into the same wall as the subdrain connection and at the same invert elevation.

410.07.16 Field Testing

410.07.16.01 General

Field tests described in this subsection shall be conducted when specified in the Contract Documents and applied to sanitary and storm pipe sewers. All tests shall be carried out in the presence of and accepted by the Contract Administrator.

When specified in the Contract Documents, leakage tests shall be carried out on completed pipe sewers 1,200 mm in diameter and smaller. There shall be no visible leakage for pipe sewers larger than 1,200 mm diameter.

Testing shall be carried out from maintenance hole to maintenance hole, including house service connections as work progresses.

The construction of new mainline pipe sewers shall not proceed when three previously placed sections of the pipe sewer have not been tested or have been tested and are unsatisfactory.

Leakage up to 25% in excess of the calculated limits shall be approved in any test section provided that the excess is offset by lower leakage measurements in adjacent sections so that the total leakage is within the allowable limits for the combined sections.

Pipe sewers shall be repaired and retested, as required, until the test results are within the limits specified in this specification. Visible leaks shall be repaired regardless of the test results.

No part of the work shall be accepted until the pipe sewers are satisfactorily tested following completion of installation of service connections and backfilling.

410.07.16.02 Prequalification Leakage Tests

Prequalification leakage tests shall be carried out as either infiltration or exfiltration tests, as required.

The test shall be performed on the first section of the pipe sewer of each size, not less than 100 m in length, installed by each crew in order to prequalify the crew and the material. Tests may be carried out prior to service connections being installed in the section being tested.

When tests are unsatisfactory, the test section shall be repaired and retested until satisfactory results are obtained.

410.07.16.03 Infiltration Test

Dewatering operations shall be discontinued at least three days prior to conducting the test and allow for the groundwater level to stabilize. Infiltration tests shall be conducted when the groundwater level at the time of testing is 600 mm or more above the crown of the pipe for the entire length of the test section. The test section is normally between adjacent maintenance holes.

A watertight bulkhead shall be constructed at the upstream end of the test section. All service laterals, stubs, and fittings shall be plugged or capped to prevent water entering at these locations. A V-notch weir or other suitable measuring device shall be installed at the downstream end of the test section. Infiltrating water shall be allowed to build up behind the weir until the flow through the V-notch has stabilized. The rate of flow shall then be measured. The rate of flow shall not exceed the maximum allowable infiltration calculated for the test section. Allowable infiltration shall be calculated as 0.075 litres/millimetre diameter/100 metres of pipe sewer/hour.

410.07.16.04 Exfiltration Test

410.07.16.04.01 General

Exfiltration tests shall be conducted when the groundwater level is lower than 600 mm above the crown of the pipe or the highest point of the highest service connection included in the test section.

The test section is normally between adjacent maintenance holes. The test section of the pipe sewer shall be isolated by temporarily plugging the downstream end and all incoming pipes of the upstream maintenance hole. All service laterals, stubs, and fittings are plugged or capped to prevent water entering at these locations.

410.07.16.04.02 Testing With Water

The test section shall be slowly filled with water ensuring that all air is removed from the line. A period of 24 hours for absorption or expansion shall be allowed prior to starting the test, except if exfiltration requirements are met by a test carried out during the absorption period.

Water shall be added to the pipeline prior to testing until there is a head in the upstream maintenance hole of 600 mm minimum over the crown of the pipe or at least 600 mm above the existing groundwater level, whichever is greater. The maximum limit of the net internal head on the line is 8 m. In calculating the net internal head, allowance for groundwater head, if any, shall be made.

The distance from the maintenance hole frame to the surface of the water shall be measured. After allowing the water to stand for one hour, the distance from the frame to the surface of the water shall again be measured. The leakage shall be calculated using volumes.

The leakage at the end of the test period shall not exceed the maximum allowable calculated for the test section. Allowable leakage shall be calculated as 0.075 litres/millimetre diameter/100 metres of pipe sewer/hour.

An allowance of 3.0 litres per hour per metre of head above the invert for each maintenance hole included in the test section shall be made.

Maintenance holes shall be tested separately, if the test section fails.

410.07.16.04.03 Low Pressure Air Testing

The Contract Administrator may allow or require testing by use of air when water is not readily available or the differential head in the test section is greater than 8 m or freezing temperatures exist.

Air control equipment that includes a shut off valve, safety valve, pressure regulating valve, pressure reduction valve and monitoring pressure gauge with pressure range from 0 to 35 kPa with minimum divisions of 0.5 kPa and accuracy of approximately 0.25 kPa shall be provided.

Tests shall be conducted between two consecutive maintenance holes. The test section shall be plugged at each end. One plug shall be equipped with an air inlet connection to fill the pipe sewer system with air.

The test section shall be filled slowly until a constant pressure of 24 kPa is maintained. If the groundwater is above the pipe sewer being tested, the air pressure shall be increased by 3.0 kPa for each 300 mm that the groundwater level is above the invert of the pipe.

The air pressure shall be stabilized for five minutes and then regulated to maintain it to 20.5 kPa plus the allowance for groundwater, if any. After the stabilization period, the time taken for a pressure loss of 3.5 kPa shall be recorded.

The time taken for a pressure drop of 3.5 kPa shall not be less than the times shown in Table 1.

If the length of the test section is greater than the length for minimum time, the new testing time shall be a product of the length of test section multiplied by the time shown in Table 1 for the appropriate size pipe.

If the results of an air test are marginal, the Contract Administrator may require the section to be retested using water.

410.07.16.05 Post Installation Inspection

The post installation inspection of pipe sewers shall be carried out by the Contract Administrator as specified in the Quality Assurance section under the following conditions:

- a) When the total combined pipe sewer length of all pipe sewer tender items is greater than or equal to 500 m; or
- b) If the total pipe sewer length of all pipe sewer tender items is less than 500 m, when at least one sewer pipe run is constructed with a pipe diameter greater than or equal to 450 mm and is greater than or equal to 50 m in length.

A competent and authorized representative of the Contractor, by completing Form PH-CC-822PIC (Sewer Section), shall certify that all pipe sewer installations, within the highway section identified, have been installed and completed in general conformance with the Contract Documents and are ready for the post installation inspection. Submission of Form PH-CC-822PIC shall be deemed to be the request to the Contract Administrator to have the post installation inspection performed at the certification stage indicated on the form. A separate Form PH-CC-822PIC shall be submitted for each construction season of the Contract to have the post installation inspection apportioned by construction season.

The Contract Administrator, upon approving the Contractor's request, within five Business Days of receipt of Form PH-CC-822PIC, shall provide notification of the start date of the post installation inspection.

Upon commencement of the post installation inspection, construction work shall be discontinued temporarily in the vicinity of a pipe sewer being inspected until the inspection of that pipe sewer has been completed.

410.07.17 Cleaning and Flushing of Pipe Sewers

At least two Business Days prior to the commencement of the post installation inspection, pipe sewers shall be prepared for inspection by cleaning and flushing. The material from the cleaning and flushing operation shall be managed as specified elsewhere in the Contract.

410.07.18 Clay Seals

Clay seals shall be placed as specified in the Contract Documents and compacted to 95% of the maximum dry density.

410.07.19 Concrete Appurtenances

Concrete appurtenances shall be constructed as specified in the Contract Documents. Concrete in concrete appurtenances shall be placed according to OPSS 904. Steel reinforcement shall be placed according to OPSS 905. Steel grating shall be installed when specified in the Contract Documents.

410.07.20 Site Restoration

Site restoration shall be according to OPSS 492.

410.07.21 Management of Excess Material

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

410.08 QUALITY ASSURANCE

410.08.01 Acceptance

Acceptance shall be according to this specification, including satisfactory completion of all replacement and remedial actions associated with identified deficiencies.

410.08.02 Post Installation Inspection Procedures

Notwithstanding that inspection for compliance with the Contract Documents will be performed during the Contractor's installation of the pipe sewers, the Contract Administrator shall carry out the post installation inspection on a number of test segments. The number of test segments per pipe sewer tender item shall account for a minimum of 25% of the total pipe sewer length on the Contract for the purpose of defining the quality of workmanship and acceptability of the pipe sewer installations.

On contracts with less than 4 pipe runs, a minimum of one test segment shall be inspected.

Selected test segments constructed with rigid pipe materials will be inspected using CCTV, zoom camera or by visual observations. Selected test segments constructed with flexible pipe materials will be inspected using CCTV, zoom camera or by visual observations and shall also be inspected for deflection using a mandrel, laser profiler or by direct measurement.

The Contract Administrator shall randomly select the test segments to be inspected on the Contract. If inspecting in a construction season, the number of test segments selected shall be apportioned across all construction seasons to comprise the total amount of test segments to be inspected.

Selected test segments shall be inspected throughout their entire length.

All CCTV, zoom camera or visual observation operations for a post installation inspection shall be performed by a certified NASSCO inspector. The certified NASSCO inspector shall also be responsible to carry out all mandrel, laser profiling or direct measurement operations on flexible test segments.

The Contractor may be present during inspection operations.

Pipe sewers that are to be installed in a preloaded or surcharged condition as specified in the Contract Documents will not be selected as a test segment and will not be subject to payment adjustments. However, these pipe sewers may be subject to a post installation inspection should poor performance and/or service arise after installation. Upon assessment of the post installation inspection submission, any repair or replacement issues shall be dealt with on a case by case basis.

410.08.03 Post Installation Inspection Assessments

The Contract Administrator shall assess the post installation inspection submissions for each test segment inspected quantifying the pipe condition statuses as per the pipe condition codes shown in Table 3.

Within 20 Business Days of receipt of Form PH-CC-822PIC, the Contract Administrator shall, for all test segments inspected, provide the Contractor, with copies of all test segment post installation inspection submissions and assessments. This will serve as notification to the Contractor if further action, based on the test segments' pipe condition statuses, is required.

410.08.04 Replacement and Repair

410.08.04.01 Replacement

All individual pipe lengths and/or joints in a test segment assessed with a "Reject" Pipe Condition status shall be replaced by the Contractor by installing new pipe lengths, service connections and/or joints as required.

The Contract Administrator shall, upon written notification from the Contractor that replacement operations have been completed, perform a replacement post installation inspection of all test segments where pipe lengths and/or joints have been replaced and shall assess the test segments' pipe condition statuses based on the replacement post installation inspection.

410.08.04.02 Repair

All individual pipe lengths and/or joints in a test segment assessed with a "Repair" Pipe Condition status shall be repaired by the Contractor.

Table 2 lists lists Owner accepted repair methods and pipe material application that may be used.

The Contractor shall submit a repair proposal to the Contract Administrator within five Business Days after receipt of the test segments' post installation inspection submissions and assessments. The Contract Administrator shall review the repair proposal within three Business Days.

Upon approval by the Contract Administrator, the Contractor shall carry out the repairs of the pipe lengths and/or joints in the test segment in accordance with the approved repair proposal.

All repair methods, measures and materials used shall be documented.

The Contract Administrator shall, upon written notification from the Contractor that repair operations have been completed, perform a follow up repair inspection on the pipe lengths and/or joints in the test segment that have been repaired to confirm that the repairs have been made by the Contractor as approved.

Notwithstanding where a test segment or portion of the test segment has been assessed by the Contract Administrator with a "Repair" Pipe Condition status and upon attempting to implement the approved repair proposal, the Contractor determines that the proposed repair measures cannot repair the test segment or portion of the test segment; the test segment or portion of the test segment shall be replaced by the Contractor.

The Contract Administrator shall, upon written notification from the Contractor that replacement operations have been completed, perform a replacement post installation inspection of the test segment in its entirety upon completion of the replacement of the test segment or portion of the test segment and shall assess the test segments' pipe condition statuses based on the replacement post installation inspection.

410.08.05 Acceptance

A pipe sewer tender item shall be accepted based on the post installation inspection assessment of selected test segments that comprise, at a minimum, 25% of the pipe quantity for that pipe sewer tender item. Additional test segments shall be added as described elsewhere in this specification.

Inspected test segments shall be assessed as follows:

Individual test segments or portions of a test segment and/or the joints in a test segment that received no Pipe Condition Code are assessed with an Acceptable Pipe Condition rating, and are not subject to price adjustment.

Individual test segments or portions of a test segment and/or the joints in a test segment that received a Repair Pipe Condition rating, and where the Contract Administrator has confirmed that the Contractor has performed the repairs using non-intrusive repair methods, are deemed acceptable and shall be upgraded to a final Acceptable Pipe Condition rating, and as such are not subject to a price adjustment.

If there are more than 2 repair deficiencies per linear metre or a common repair deficiency is found on 15% or more of the pipe lengths or joints in the test segments inspected where non-intrusive repair measures were used to perform the repairs, the Contract Administrator shall randomly select, at a minimum, an equivalent amount of additional test segments for the post installation inspection.

Individual test segments or portions of a test segment and/or the joints in a test segment that received a Threshold Pipe Condition rating are acceptable, however, are subject to a price adjustment.

If there are more than 2 threshold deficiencies per linear metre or a common threshold deficiency is found on 25% or more of the pipe lengths and/or joints in the test segments inspected, the Contract Administrator shall randomly select, at a minimum, an equivalent amount of additional test segments for the post installation inspection.

Individual test segments or portions of a test segment and/or the joints in a test segment that received a Repair Pipe Condition rating, and where the Contract Administrator has confirmed that the Contractor has performed the repairs using intrusive repair methods, are deemed to be adequate and the entire test segment shall be upgraded to a final Repaired Pipe Condition rating, however, is subject to a price adjustment.

If repair deficiencies were found and intrusive measures were used to repair an individual test segment or portions of test segments, the Contract Administrator shall randomly select, at a minimum, an equivalent amount of additional test segments for the post installation inspection.

Individual test segments or portions of a test segment and/or joints in a test segment that received a Reject Pipe Condition rating are not acceptable.

Of the individual test segments or portions of a test segment and/or the joints in the test segments inspected, if 10% or more of the test segments and/or joints received a Reject Pipe Condition rating, the Contract Administrator shall randomly select, at a minimum, an equivalent amount of additional test segments for the post installation inspection.

410.08.06 Referee Testing

The Contractor may request referee testing on individual test segments or portions of a test segment that received a "Repair", "Reject" or "Threshold" Pipe Condition Status.

Referee testing may only be invoked within five Business Days of the Contractor receiving copies of the test segments' post installation inspection submission and the assessment results.

Referee testing shall be done through the following procedure:

- a) The Contractor shall identify the assessments of individual test segments or portions of any test segments that they disagree with;
- b) The Contract Administrator shall arrange for a referee post installation inspection to be performed by an independent NASSCO certified, third party inspector using the same inspection criteria, type of

equipment and techniques as was used for the original post installation inspection on the test segments under disagreement;

- c) The Contract Administrator shall assess the referee post installation inspection submission, which replaces the original post installation inspection submission, for each test segment or portions of test segments under disagreement which will then be binding on both parties; and
- d) The Contract Administrator shall provide the Contractor with copies of the test segment referee post installation inspection submissions and assessments which will serve as notification to the Contractor if further action, based on the pipe condition statuses, is required.

410.08.07 Final Pipe Condition Assessment Rating

The Contract Administrator shall assign final Pipe Condition Assessment Ratings (PCAR) as follows:

A PCAR of "R" is assigned to those test segments that, either in part or in whole, initially received a Repair Pipe Condition Status and have been upgraded to a Repaired Pipe Condition Status;

and for the remaining test segments:

A PCAR of "A" is assigned to the portion of these remaining test segment lengths that received an Acceptable Pipe Condition Status; and

A PCAR of "T" is assigned to the portion of these remaining test segment lengths that received a Threshold Pipe Condition Status.

410.09 MEASUREMENT FOR PAYMENT

410.09.01 Actual Measurement

410.09.01.01 Pipe Sewers

Measurement of pipe sewers shall be by length in metres along the horizontal centreline length of the pipe from the centre of one drainage structure to the centre of another drainage structure or outlet end of the pipe sewer. When the grade of the pipe sewer is 10% or greater, the above measurement is then of the slope length.

410.09.01.02 Service Connections

Measurement of the service connections shall be by length in metres along its horizontal centreline from the centreline of the main pipe sewer to the end of the service connection.

410.09.01.03 Breaking into Maintenance Holes, Catch Basins, Ditch Inlets, Pipe Culverts, and Pipe Sewers

For measurement purposes, a count shall be made of the number of openings made in maintenance holes, catch basins, ditch inlets, pipe culverts and pipe sewers.

410.09.01.04 Concrete Appurtenances

Measurement for concrete appurtenances shall be by volume in cubic metres for the volume of concrete placed. Alternatively, concrete appurtenances may be a lump sum item.

410.09.01.05 Clay Seal

Measurement for clay seal shall be by volume in cubic metres for the volume of clay placed. Alternatively, clay seal may be a lump sum item.

410.09.02 Plan Quantity Measurement

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

410.10 BASIS OF PAYMENT

410.10.01 "size, type, class" Pipe Sewers - Item Service Connections - Item Breaking into Maintenance Holes, Catch Basins, Ditch Inlets, Culverts and Sewers - Item Concrete Appurtenances - Item Clay Seal – Item

Payment at the Contract price for the above tender items shall be full compensation for all Labour, Equipment, and Material to do the work, subject to the payment adjustments as specified in this specification.

Costs for the replacement and/or repair of test segments including but not limited to the associated costs for the reinstatement of the highway structure and all ancillary features previously constructed above the test segments shall be at the Contractor's expense at no additional cost to the Owner. Costs for any delays associated with the repair and/or replacement of the test segments and the reinstatement of the highway structure and all ancillary features previously constructed above the test segments shall also be at the Contractor's expense at no additional cost to the Owner.

The cost of traffic control for the post installation inspection shall be at the Contractor's expense at no additional cost to the Owner.

The cost for inspection of additional test segments in the post installation inspection, follow up repair inspection and/or replacement post installation inspection, including traffic control, according to the Acceptance of Pipe Sewers clause shall be at the Contractor's expense at no additional cost to the Owner.

The cost for referee post installation inspection, including traffic control, according to the Referee Testing clause shall:

- a) Where the assessment of the referee post installation inspection confirms the original pipe condition status, be borne by the Contractor; or
- b) Where the assessment of the referee post installation inspection upgrades the original pipe condition status, be borne by the Owner; or
- c) Where the assessment of the referee post installation inspection upgrades a portion of the original pipe condition status, be apportioned between the Contractor and the Owner based on the final upgraded and confirmed pipe proportions respectively.

410.10.02 Price Adjustment Factor

Price Adjustment Factors (PAF) for each PCAR is noted as follows:

PCAR of "A" is subject to a PAF equal to 1;

PCAR of "R" is subject to a PAF equal to 0.75. and

PCAR of "T" is subject to a PAF equal to 0.85.

410.10.02.01 Application to Pipe Sewer Tender Items

A Weighted Price Adjustment Factor (WPAF) is calculated for each pipe sewer tender item that had test segments inspected and is applied against that pipe sewer tender item only. Each pipe sewer tender item that had test segments inspected will have a unique WPAF.

Any test segments with a PCAR of "R" are price adjusted separately as described in the Application to Repaired Test Segments clause.

The WPAF for a pipe sewer tender item is calculated using the total pipe length of those remaining test segments that have PCAR of "A" and "T" only.

The Contract Administrator shall calculate the WPAF for a pipe sewer tender item based on the "A" and "T" portions of the remaining test segments lengths, as follows:

WPAF =

$$\frac{\text{PAF (A) x "A" portion of remaining test segments' length} + \text{PAF (T) x "T" portion of remaining test segments' length}}{\text{Total pipe length of remaining test segments}}$$

This WPAF shall be applied to determine the payment adjustment for the tender item quantity minus the total quantity of test segments in that tender item that have a PCAR of "R".

410.10.02.02 Application to Repaired Test Segments

This individual WPAF is applied to all test segments that are rated "R". A separate WPAF is calculated for each test segment that is rated "R" within a pipe sewer tender item.

The Contract Administrator shall calculate the unique WPAF for each test segment with an "R" rating based on the applicable "A", "R" and "T" ratings as follows:

WPAF =

$$\frac{\text{PAF (A) x test segment length rated "A"} + \text{PAF (R) x test segment length rated "R"} + \text{PAF (T) x test segment length rated "T"}}{\text{Total repaired test segment length}}$$

This WPAF shall be applied to determine the payment adjustment for the repaired test segments in that tender item.

410.10.02.03 Payment Adjustments for Pipe Sewers

Tender item payment adjustments shall be applied only to inspected pipe sewer tender items and associated repaired test segments within the highway section as identified on Form PH-CC-822PIC.

Tender item payment adjustments in the current construction season are not subject to any WPAF as may have been determined through the post installation inspection or a referee post installation inspection carried out in previous construction seasons for the same tender item.

To calculate the payment adjustment for an inspected tender item excluding the repaired test segments in the tender item, the following formula using the unique WPAF applicable to the tender item shall be used:

$$\text{Pay. Adjust.} = (\text{Quantity Installed} - \text{Repaired Test Segments Quantity}) \times \text{Contract Price} \times (\text{WPAF} - 1.00)$$

A payment adjustment shall be calculated separately for each tender item that had test segments inspected.

To calculate the payment adjustment for repaired test segments in a tender item, the following formula using the unique WPAF applicable to the repaired test segment shall be used:

$$\text{Pay. Adjust.} = \text{Repaired Test Segment Quantity} \times \text{Contract Price} \times (\text{WPAF} - 1.00)$$

A payment adjustment shall be calculated separately for each repaired test segment that has been assessed with a different WPAF or is from a different tender item. Repaired test segments shall be grouped only if they are from the same tender item and have the same WPAF.

When the payment adjustment is zero, there is no payment change. When the payment adjustment is negative, it is a payment reduction.

TABLE 1
Exfiltration Test - Low Pressure Air Testing

NominalPipe Size mm	MinimumTime min:sec	Length for Minimum Time m	Time For Longer Length sec
100	1:53	182	0.623
150	2:50	121	1.140
200	3:47	91	2.493
250	4:43	73	3.893
300	5:40	61	5.606
375	7:05	48	8.761
450	8:30	41	12.615
525	9:55	35	17.171
600	11:20	30	22.425
675	12:45	27	28.382
750	14:10	24	35.040
825	15:35	22	42.397
900	17:00	20	50.450

Table 2 Accepted Repair Methods			
Repair Method Impact	Repair Method	Pipe Material Application	Repair Method Description
Non-intrusive	Epoxy injection	Concrete	Filling entire fracture with epoxy material to seal against leakage
	High pressure chemical grout	Concrete	Pumping chemical grout into entire fracture to fill the void(s) behind the pipe wall to preserve the structural integrity of the pipe and seal against leakage
	Patching	Concrete	Filling spalled or chipped pipe wall areas with concrete material to prevent early exposure of reinforcing steel bars
	Re-rounding	Steel, HDPE or PVC	Reinstating a flexible pipe to the accepted construction tolerance or Owner acceptance limits
Intrusive	Fold and form	Concrete	Placement of a length of softened pipe material into a pipe installation and expanding to “fit” the inner dimensions of the deficient pipe in order to seal against leakage and maintaining 90% of original flow area.
	Lining	Concrete	Insertion of a short length of smaller pipe into a larger gravity pipe installation and sealing the area between the pipes with grout to provide structural integrity and seal against leakage and maintaining 90% of original flow area.
	Internal sleeve	Concrete	Insertion of a complete smaller gravity pipe installation into a larger gravity pipe installation and sealing the area between the pipes with grout to provide structural integrity seal against leakage and maintaining 90% of original flow area.

Table 3 Gravity Pipe Codes and Associated Pipe Condition Status							
Pipe Condition Status Assessment		Threshold □	Repair ▣	Reject ■	Not Applicable -		
Pipe Condition Codes	Pipe Code Description and Attributes	Rigid Pipe Applications			Flexible Pipe Applications		
		Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)	Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)
B	Broken pipe has noticeable displacement of cracked pipe wall segments where the breaks show half the pipe wall thickness or greater for thick walled pipe or there is clear visible separation between pipe wall segments for thin (≤ 8.0 mm) walled pipe	■	■	■	■	■	■
CC	Circumferential crack is visible and apparent but crack edges are not visibly open and the crack spans more than 1 but less than 2 clock reference segments (i.e. between 1 to 3 o'clock)	□	□	□	-	-	-
	Circumferential crack is visible and apparent but crack edges are not visibly open and the crack spans 3 or more clock reference segments (i.e. greater than 1 to 4 o'clock)	■	■	■	-	-	-
	Circumferential crack is visible and apparent but crack edges are not visibly open	-	-	-	■	■	■
CL	Longitudinal crack is visible and apparent but crack edges are not visibly open and the crack is $\geq 1/3$ and $\leq 1/2$ of individual pipe length	□	□	□	-	-	-
	Longitudinal crack is visible and apparent but crack edges are not visibly open and the crack is $> 1/2$ of individual pipe length	■	■	■	-	-	-
	Longitudinal crack is visible and apparent but crack edges are not visibly open	-	-	-	■	■	■
CM	Multiple cracks (CC, CL and CS) are several cracks that are visible and apparent but crack edges are not visibly open	■	■	■	■	■	■

Table 3 Gravity Pipe Codes and Associated Pipe Condition Status							
Pipe Condition Status Assessment		Threshold □	Repair ◻	Reject ■	Not Applicable -		
Pipe Condition Codes	Pipe Code Description and Attributes	Rigid Pipe Applications			Flexible Pipe Applications		
		Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)	Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)
CS	Spiral crack is visible and apparent but crack edges are not visibly open and the crack is $\geq 1/3$ and $\leq 1/2$ of individual pipe length	□	□	□	-	-	-
	Spiral crack is visible and apparent but crack edges are not visibly open and the crack is $\geq 1/2$ of individual pipe length	■	■	■	-	-	-
	Spiral crack is visible and apparent but crack edges are not visibly open	-	-	-	■	■	■
FC	Circumferential fracture is a crack where the edges are visibly separated with an opening width that is ≤ 0.6 mm and is ≤ 1 clock reference segments (i.e. between 1 to 2 o'clock)	□	□	□	-	-	-
	Circumferential fracture is a crack where the edges are visibly separated with an opening width that is ≤ 0.6 mm and is > 1 and ≤ 2 clock reference segments (i.e. between 1 to 3 o'clock)	◻	◻	◻	-	-	-
	Circumferential fracture is a crack where the edges are visibly separated with an opening width that is ≤ 0.6 mm and is more than 2 clock reference segments (i.e. greater than 1 to 3 o'clock)	■	■	■	-	-	-
	Circumferential fracture is a crack where the edges are visibly separated with an opening width that is > 0.6 mm and > 1 and ≤ 2 clock reference segments (i.e. between 1 to 3 o'clock)	◻	◻	◻	-	-	-
	Circumferential fracture is a crack where the edges are visibly separated with an opening width that is > 0.6 mm and is more than 2 clock reference segments (i.e. greater than 1 to 3 o'clock)	■	■	■	-	-	-
	Circumferential fracture is a crack where the edges are visibly separated	-	-	-	■	■	■

Table 3 Gravity Pipe Codes and Associated Pipe Condition Status							
Pipe Condition Status Assessment		Threshold □	Repair ◻	Reject ■	Not Applicable -		
Pipe Condition Codes	Pipe Code Description and Attributes	Rigid Pipe Applications			Flexible Pipe Applications		
		Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)	Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)
FL	Longitudinal fracture is a crack where the edges are visibly separated with an opening width that is ≤ 0.6 mm and the crack is $\geq 1/3$ and $\leq 1/2$ of individual pipe length	□	□	□	-	-	-
	Longitudinal fracture is a crack where the edges are visibly separated with an opening width that is ≤ 0.6 mm and the crack is $> 1/2$ of individual pipe length	■	■	■	-	-	-
	Longitudinal fracture is a crack where the edges are visibly separated with an opening width that is > 0.6 mm and the crack is $\geq 1/3$ and $\leq 1/2$ of individual pipe length	◻	◻	◻	-	-	-
FL	Longitudinal fracture is a crack where the edges are visibly separated with an opening width that is > 0.6 mm and the crack is $> 1/2$ of individual pipe length	■	■	■	-	-	-
	Longitudinal fracture is a crack where the edges are visibly separated	-	-	-	■	■	■
FM	Multiple fracture (FC, FL and FS) are several cracks where the edges are visibly separated	■	■	■	■	■	■

Table 3 Gravity Pipe Codes and Associated Pipe Condition Status									
Pipe Condition Status Assessment		Threshold □	Repair ◻	Reject ■	Not Applicable -				
Pipe Condition Codes	Pipe Code Description and Attributes		Rigid Pipe Applications			Flexible Pipe Applications			
			Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)	Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)	
FS	Spiral fracture is a crack where the edges are visibly separated with an opening width that is ≤ 0.6 mm and the crack is $\geq 1/3$ and $\leq 1/2$ of individual pipe length		□	□	□	-	-	-	
	Spiral fracture is a crack where the edges are visibly separated with an opening width that is ≤ 0.6 mm and the crack is $> 1/2$ of individual pipe length		■	■	■	-	-	-	
	Spiral fracture is a crack where the edges are visibly separated with an opening width that is > 0.6 mm and the crack is $\geq 1/3$ and $\leq 1/2$ of individual pipe length		◻	◻	◻	-	-	-	
	Spiral fracture is a crack where the edges are visibly separated with an opening width that is > 0.6 mm and the crack is $> 1/2$ of individual pipe length		■	■	■	-	-	-	
	Spiral fracture is a crack where the edges are visibly separated		-	-	-	■	■	■	
H	Visible hole in the pipe sewer wall		■	■	■	■	■	■	
D	Deformed Pipe determined by visual techniques	right or left side only $> 5\%$ and ≥ 2 clock references (i.e. greater than 1 to 3 o'clock)	-	-	-	■	■	■	
		upper or lower left or right quadrants $> 5\%$ and ≥ 2 clock references (i.e. greater than 1 to 3 o'clock)	-	-	-	■	■	■	
D	Deformed Pipe determined by deflection measurements	≤ 750 mm	$> 5\%$ and $\leq 7.5\%$	-	-	-	□	□	□
			$> 7.5\%$ and $\leq 10\%$	-	-	-	◻	◻	◻
			$> 10\%$	-	-	-	■	■	■
		> 750 mm	$> 5\%$ and $\leq 7.5\%$	-	-	-	◻	◻	◻
			$> 7.5\%$	-	-	-	■	■	■

Table 3 Gravity Pipe Codes and Associated Pipe Condition Status							
Pipe Condition Status Assessment		Threshold ☐	Repair ☐	Reject ☒	Not Applicable -		
Pipe Condition Codes	Pipe Code Description and Attributes	Rigid Pipe Applications			Flexible Pipe Applications		
		Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)	Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)
DE	Settled deposits in the pipe blocking > 10% of cross sectional area, regardless of material composition	☐	☐	☐	☐	☐	☐
DI	Dropped invert of individual pipe lengths or at end of sewer run or culvert	☒	☒	☒	☒	☒	☒
JDM	Pipe lengths have slid apart at the joint with a separation distance between pipe length edges that is ≥ 50 mm and ≤ 75 mm, however, there is no opening where the pipe fill material is visible	☐	☐	☐	☐	☐	☐
JDL	Pipe lengths have slid apart at the joint with a separation distance between pipe length edges that is > 75 mm, however, there is no opening where the pipe fill material is visible	☒	☐	☐	☒	☐	☐
LL or LR	Line deviations left or right by > 5 and ≤ 10 degrees as applied to straight pipe run installations	☐	☐	☐	☐	☐	☐
	Line deviations left or right by > 10 degrees and ≤ 20 degrees as applied to straight pipe run installations	☐	☐	☐	☐	☐	☐
	Line deviations left or right by > 20 degrees as applied to straight pipe run installations	☒	☒	☒	☒	☒	☒
LD or LU	Line deviations up or down by > 5 and ≤ 10 degrees as applied to straight pipe run installations	☐	☐	☐	☐	☐	☐
	Line deviations up or down by > 10 degrees as applied to straight pipe run installations	☒	☒	☒	☒	☒	☒
OB	An obstruction is apparent in the pipe and is not a feature that has been built into or inserted into the pipe	☐	☐	☐	☐	☐	☐
OJM	Pipe lengths have slid apart at the joint displaying an opening where pipe fill material is visible and the opening width is ≥ 50 mm and ≤ 75 mm	☒	☐	☐	☒	☐	☐

Table 3 Gravity Pipe Codes and Associated Pipe Condition Status							
Pipe Condition Status Assessment		Threshold ☐	Repair ☐	Reject ☒	Not Applicable -		
Pipe Condition Codes	Pipe Code Description and Attributes	Rigid Pipe Applications			Flexible Pipe Applications		
		Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)	Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)
OJL	Pipe lengths have slid apart at the joint displaying an opening where pipe fill material is visible and the opening width is > 75 mm	☒	☐	☐	☒	☐	☐
IS	Infiltration seeping is the slow ingress of water into the pipe through a fracture with crack width opening ≤ 0.6 mm but there are no visible drips	☐	☐	☐	☒	☒	☒
	Infiltration seeping is the slow ingress of water into the pipe through a fracture with crack width opening > 0.6 mm but there are no visible drips	☐	☐	☐	☒	☒	☒
	Infiltration seeping is the slow ingress of water into the pipe through a joint (JDM) but there are no visible drips	☒	☐	☐	☒	☐	☐
	Infiltration seeping is the slow ingress of water into the pipe through a joint (JDL) but there are no visible drips	☒	☐	☐	☒	☐	☐
ID	Infiltration dripping is water dripping into the pipe through a fracture with crack width opening ≤ 0.6 mm but not in a continuous flow	-	-	-	☒	☒	☒
	Infiltration dripping is water dripping into the pipe through a fracture with crack width opening > 0.6 mm but not in a continuous flow	☐	☐	☐	☒	☒	☒
	Infiltration dripping is water dripping into the pipe through a joint (JDM) but not in a continuous flow	☐	☐	☐	☐	☐	☐
ID	Infiltration dripping is water dripping into the pipe through a joint (JDL) but not in a continuous flow	☒	☐	☐	☒	☐	☐
IR	Infiltration running is water running into the pipe through a fracture with crack width opening ≤ 0.6 mm and a continuous flow is visible	☐	☐	☐	☒	☒	☒

Table 3 Gravity Pipe Codes and Associated Pipe Condition Status							
Pipe Condition Status Assessment		Threshold ☐	Repair ☐	Reject ☒	Not Applicable -		
Pipe Condition Codes	Pipe Code Description and Attributes	Rigid Pipe Applications			Flexible Pipe Applications		
		Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)	Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)
IR	Infiltration running is water running into the pipe through a joint and a continuous flow is visible	☐	☐	☐	☐	☐	☐
IG	Infiltration gushing is water entering the pipe through a fracture or joint under pressure but may not necessarily be a heavy flow	☒	☒	☒	☒	☒	☒
SWM	Surface Damage to pipe coating by abrasion, wear or other installation related damages on galvanized, aluminized Type II and/or polymer laminated steel pipes where the damage area's linear measurement is $\leq 10\%$ of individual pipe length and the damage area's widest width measurement is ≤ 2 clock segments (i.e. between 1 to 3 o'clock)	-	-	-	☐	☐	☐
SWL	Surface Damage to pipe coating damage by abrasion, wear or other installation related damages on galvanized, aluminized Type II and/or polymer laminated steel pipes where the damage area's linear measurement is $> 10\%$ of individual pipe length and the damage area's widest width measurement is > 2 clock segments (i.e. greater than 1 to 3 o'clock)	-	-	-	☒	☒	☒
SWM	Surface wear in the context of abrasion, wear or other installation related damages to the inner surface of HDPE and PVC pipe products where the damage area's linear measurement is $\leq 10\%$ of individual pipe length and the damage area's widest width measurement is ≤ 2 clock segments (i.e. between 1 to 3 o'clock)	-	-	-	☐	☐	☐
SWL	Surface wear in the context of abrasion, wear or other installation related damages to the inner surface of HDPE and PVC pipe products where the damage area's linear measurement is $> 10\%$ of individual pipe length and the damage area's widest width measurement is > 2 clock segments (i.e. greater than 1 to 3 o'clock)	-	-	-	☒	☒	☒

Table 3 Gravity Pipe Codes and Associated Pipe Condition Status							
Pipe Condition Status Assessment		Threshold ☐	Repair ☐	Reject ☒	Not Applicable -		
Pipe Condition Codes	Pipe Code Description and Attributes	Rigid Pipe Applications			Flexible Pipe Applications		
		Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)	Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)
SSM	Surface Damage in the context of spalling where inner surface is splintered or chipped where total area coverage is ≥ 0.5 and ≤ 1.0 m in length and ≤ 2 clock reference segments in width (i.e. between 1 to 3 o'clock)	☐	☐	☐	-	-	-
SSL	Surface Damage in the context of spalling where inner surface is splintered or chipped where total area coverage is > 1.0 m in length and > 2 clock reference segments in width (i.e. greater than 1 to 3 o'clock)	☒	☒	☒	-	-	-
SR	Sealing ring at the pipe joint is displaced and intruding into the pipe	☐	☐	☐	☐	☐	☐
SRB	Sealing ring at the pipe joint is broken	☐	☐	☐	☐	☐	☐
X	Collapsed Pipe $> 50\%$ of cross sectional area lost	☒	☒	☒	☒	☒	☒
JX	Pipe junction defective means that the junction is damaged or incorrectly positioned	☒	☒	☒	☒	☒	☒
CNI	Service Connection intruding means that the connection is jutting into the drainage structure	☐	☐	☐	☐	☐	☐
CX	Service Connection defective means that the connection is damaged or incorrectly positioned	☒	☒	☒	☒	☒	☒
CXI	Service Connection defective and intruding means that the connection is damaged or incorrectly positioned and is jutting into the drainage structure	☒	☒	☒	☒	☒	☒

*** Note:**

Gravity pipe sewer requirements are as specified in the Pipe Joints column of the Quantities – Sewers contract sheets. The requirements are:

S for soil tight (replaces N);
F for silt or fines tight (replaces L); and
L for water or leak tight (replaces H).

Pipe Condition Codes are the standard condition classification codes as identified in the Manual of Sewer Condition Classification.



Figure 1
CSA Standards
Certification Logo

Appendix 410-A, November 2015
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

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

Designer Action/Considerations

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR PIPE CULVERT INSTALLATION IN OPEN CUT

TABLE OF CONTENTS

421.01	SCOPE
421.02	REFERENCES
421.03	DEFINITIONS
421.04	DESIGN AND SUBMISSION REQUIREMENTS - Not Used
421.05	MATERIALS
421.06	EQUIPMENT - Not Used
421.07	CONSTRUCTION
421.08	QUALITY ASSURANCE
421.09	MEASUREMENT FOR PAYMENT
421.10	BASIS OF PAYMENT

APPENDICES

421-A	Commentary
--------------	-------------------

421.01 SCOPE

This specification covers the requirements for the installation and inspection of pipe culverts, pipe culvert end sections, and concrete appurtenances in open cut.

421.01.01 Specification Significance and Use

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

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

421.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

421.02 REFERENCES

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

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

Ontario Provincial Standards Specifications, Construction

OPSS 206	Grading
OPSS 401	Trenching, Backfilling, and Compacting
OPSS 404	Support Systems
OPSS 409	Closed-Circuit Television (CCTV) Inspection of Pipelines
OPSS 490	Site Preparation for Pipelines, Utilities, and Associated Structures
OPSS 491	Preservation, Protection, and Reconstruction of Existing Facilities
OPSS 492	Site Restoration Following Installation of Pipelines, Utilities, and Associated Structures
OPSS 510	Removal
OPSS 517	Dewatering of Pipeline, Utility, and Associated Structure Excavation
OPSS 539	Temporary Protection Systems
OPSS 904	Concrete Structures
OPSS 905	Steel Reinforcement for Concrete

Ontario Provincial Standard Specifications, Material

OPSS 1004	Aggregates - Miscellaneous
OPSS 1205	Clay Seal
OPSS 1301	Cementing Materials
OPSS 1302	Water
OPSS 1350	Concrete - Materials and Production
OPSS 1440	Steel Reinforcement for Concrete
OPSS 1801	Corrugated Steel Pipe Products
OPSS 1820	Circular Concrete Pipe

OPSS 1840	Non-Pressure Polyethylene Plastic Pipe Products
OPSS 1841	Non-Pressure Polyvinyl Chloride (PVC) Pipe Products
OPSS 1843	Non-Pressure Polypropylene (PP) Plastic Pipe Products
OPSS 1860	Geotextiles

CSA Standards

G401	Corrugated Steel Pipe Products
------	--------------------------------

ASTM International

B 746	Corrugated Aluminum Alloy Structural Plate for Field-Bolted Pipe, Pipe-Arches, and Arches
C 507-12	Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe

Other

WRc Manual of Sewer Condition Classification (MSCC), Fourth and/or Third Edition

421.03 DEFINITIONS

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

Acceptable Pipe Condition Status means the assessment designation assigned to an installed gravity pipe installation that has no deficiencies.

Aluminum Alloy means a material made with two or more metals in which aluminum is the predominant metal.

Backfilling means the operation of filling the trench with bedding, cover, and backfill material or embedment and backfill material.

CCTV means closed-circuit television used to inspect a gravity pipe installation.

Certification Body means an independent 3rd party agency accredited by the Standards Council of Canada that has the qualifications, skills, and expertise required to confirm that a pipe manufacturer produces pipe products to the quality and requirements of an accepted standard and that has the mandate to certify the pipe products produced.

Certified means pipe products that have been marked with a certification body's logo confirming that the production of the pipe product is in accordance with the quality and requirements of the manufacturing standard.

Concrete Appurtenances means concrete head walls, cut-off walls, stiffeners, aprons, collars, and any other concrete fixtures associated with the pipe culvert, excluding concrete bedding or concrete structures specified in the Contract Documents.

Delivered Quality means the pipe products' physical condition upon arrival at the construction site in terms of the extent and degree of dents, scratches, cracks, pipe coating integrity, etc., that appear on the pipe products delivered.

Direct Measurement means measuring pipe parameters such as diameters to determine deflections or the offsets/displacements at joints/service connections to determine pipe joint integrity in a gravity pipe installation using a measuring tape, pre-measured rod or other suitable measuring devices.

Excavation, Earth and Rock means the excavation classified as earth and rock according to OPSS 206.

Flexible Pipe means pipe that can deflect 2% or more without cracking, such as polyvinyl chloride, polyethylene, or steel pipe.

Gravity Pipe Installation means a constructed pipe system conveying surface waters under the influences of gravity only and can be a pipe sewer or a pipe culvert.

Inspection Assessment means evaluating the findings of a post installation inspection and quantifying the pipe condition status of the gravity pipe installation.

Laser Profiler means an instrument that uses a light ring to survey, locate, measure and report profile, deflection and dimensional attributes, including anomalies, in a gravity pipe installation.

Mandrel means an instrument equipped with an odd number of arms that is pulled through a flexible gravity pipe installation to determine deflection anomalies.

NASSCO means the National Association of Sewer Service Companies which certifies inspectors to perform inspection of pipe sewers and culverts and code viewed pipe conditions.

Pipe Class means a pipe's physical material specification, such as load and pressure ratings, wall thickness, protective coatings, corrugation profiles, ring stiffness constants, and reinforcement.

Pipe Condition Assessment Rating means the final gravity pipe installations' acceptance rating that is given to the pipe based on the evaluation of the final post installation inspection results inclusive of both original and additional test segments from the post installation inspection, referee post installation inspection and follow up repair inspection.

Pipe Condition Coding means the assignment of code designations to pipe attributes such as pipe materials, walls, joints, service connections or any other physical pipe characteristics.

Pipe Condition Status means the designation assigned to the gravity pipe installation based on the assessment of the post installation inspection results.

Pipe Culvert means an installation designed to provide for the conveyance of surface water, pedestrians, or livestock using preformed or precast pipe sections, circular or non-circular in cross-section, laid end to end using suitable joint materials.

Pipe Type means a pipe's inner wall design, which can be smooth or corrugated.

Polypropylene Plastic means a material made with virgin polymers in which propylene is essentially the sole monomer.

Post Installation Inspection means quantifying the final installed condition of gravity pipe installations using accepted surveillance and measuring methods.

Reject Pipe Condition Status means the designation assigned to an installed gravity pipe installation, pipe lengths, pipe fittings and/or pipe service connections that have deficiencies that cannot be repaired to maintain the structural integrity or design service life of the gravity pipe installation or has certain measurable pipe attributes that are beyond Owner acceptance limits.

Repair Pipe Condition Status means the designation assigned to an installed gravity pipe installation, pipe lengths, pipe fittings and/or pipe service connections that have deficiencies that can be repaired to maintain the structural integrity and design service life of the gravity pipe installation.

Repaired Pipe Condition Status means the designation assigned to installed gravity pipe installations, pipe lengths, pipe fittings and/or pipe service connections with a Repair Pipe Condition Status that have been repaired using acceptable intrusive repair measures.

Replacing means the removal of any gravity pipe installations, pipe lengths, pipe fittings and/or pipe service connections and reinstalling the gravity pipe installation, pipe lengths, pipe fittings and/or pipe service connections to contract specifications.

Threshold Pipe Condition Status is the designation assigned to an installed gravity pipe installation, pipe lengths, pipe fittings and/or pipe service connections that have certain measurable pipe attributes that are beyond accepted construction limitations but are still within Owner acceptance limits and requires no remediation actions.

Test Segment means an individual sewer pipe run or pipe culvert that has been selected to have a post installation inspection performed on it.

Visual Observation Inspection means coding and describing the profiles, deflection and dimensional features, including anomalies, in a gravity pipe installation using direct human entry into the pipe sewer run or pipe culvert.

Zoom Camera means a stationary video camera fitted with a tele-objective zoom lens and high-powered floodlights and used to inspect a gravity pipe installation.

421.05 MATERIALS

421.05.01 Pipe Materials

421.05.01.01 General

Pipe culvert size, type, and class shall be as specified in the Contract Documents.

Pipe culvert type shall be consistent throughout the length of the pipe culvert as specified in the Contract Documents.

Fittings shall be suitable for and compatible with the pipe type and class for which they will be used.

421.05.01.02 Concrete Pipe

Circular concrete pipe and joints shall be according to OPSS 1820.

Elliptical concrete pipe and joints shall be according to ASTM C 507.

421.05.01.03 Corrugated Steel Pipe Products

Corrugated steel pipe products shall be according to OPSS 1801.

Steel structural plate pipe with polymer coating shall be according to CSA G401.

421.05.01.04 Polyethylene Pipe Products

Polyethylene pipe products shall be according to OPSS 1840.

421.05.01.05 Polyvinyl Chloride Pipe Products

Polyvinyl chloride pipe products shall be according to OPSS 1841.

421.05.01.06 Polypropylene Plastic Pipe Products

Polypropylene plastic pipe products shall be according to OPSS 1843.

421.05.01.07 Aluminum Alloy Pipe Products

Corrugated aluminum alloy structural plate pipe products shall be according to ASTM B746.

All corrugated aluminum alloy structural plate pipe products used on the Contract shall be certified and supplied from a manufacturer that produces the corrugated aluminum alloy structural plate pipe products according to ASTM B746. Only products with an accepted certification body logo marking as shown in Figure 1 shall be used.

Inspection, testing, and record keeping for corrugated aluminum alloy structural plate pipe products shall be according to ASTM B746.

Certified corrugated aluminum alloy structural plate pipe shall be marked according to ASTM B746, and shall include as a minimum the logo of the certification body and name of the pipe manufacturer.

When requested by the Owner, a copy of the certificate of compliance issued by the certification body confirming that the manufacturer produces certified corrugated aluminum alloy structural plate pipe products shall be submitted to the Contract Administrator.

The cost of all testing, except that performed in the Owner's laboratory, shall be included in the price. Where the delivered quality of certified corrugated aluminum alloy structural plate pipe products is deemed to be unacceptable by the Contract Administrator, the products shall be rejected.

421.05.02 Mortar

Mortar for joints shall consist of one part Portland cement and two parts mortar sand, wetted with sufficient water to only make the mixture plastic. The mortar sand shall be according to OPSS 1004, the normal Portland cement shall be according to OPSS 1301, and the water shall be according to OPSS 1302.

421.05.03 Clay Seal

Clay seal material shall be according to OPSS 1205.

421.05.04 Concrete

Concrete for concrete appurtenances shall be according to OPSS 1350 with a nominal minimum 28-Day compressive strength of 30 MPa.

421.05.05 Steel Reinforcement

Steel reinforcement shall be of the size and grade specified in the Contract Documents and shall be according to OPSS 1440.

421.05.06 Geotextile

Geotextile shall be according to OPSS 1860.

421.07 CONSTRUCTION

421.07.01 Site Preparation

Site preparation shall be according to OPSS 490.

421.07.02 Removals

Removals shall be according to OPSS 510.

421.07.03 Preservation and Protection of Existing Facilities

Preservation and protection of existing facilities shall be according to OPSS 491.

421.07.04 Protection Against Floatation

Damage to the pipeline due to floatation shall be prevented during construction and until completion of the work.

421.07.05 Cold Weather Work

All work shall be protected from freezing. Pipes and bedding material shall not be placed on frozen ground.

421.07.06 Transporting, Unloading, Storing, and Handling Pipe

Manufacturer's recommendations for transporting, unloading, storing, and handling of pipe, shall be followed.

All pipes, fittings, and gaskets that are unsound or damaged shall be rejected.

421.07.07 Excavation

Excavation for the placement of pipe culverts shall be according to OPSS 401.

421.07.08 Support Systems

Support systems shall be according to OPSS 404.

421.07.09 Dewatering

Dewatering shall be according to OPSS 517.

421.07.10 Protection Systems

The construction of all protection systems shall be according to OPSS 539. When the stability, safety or function of an existing roadway, railway, other works, or proposed works may be impaired due to the method of operation, such protection as may be required shall be provided. Protection may include sheathing, shoring and driving piles, when necessary, to prevent damage to such works or proposed works.

421.07.11 Backfilling and Compacting

Backfilling and compacting shall be according to OPSS 401.

421.07.12 Pipe Installation

421.07.12.01 General

If a universal dimple coupler or any other coupler does not follow the contour of the flexible pipe sections to be joined, polyethylene gaskets shall then be installed at all joints when such couplers are used. Polyethylene gaskets shall be installed symmetrically about the pipe joint, between the coupler and the pipe, and shall be of sufficient length to equal the circumference of the pipe plus a minimum overlap of 300 mm.

Pipe shall be laid within the alignment and grade tolerances specified in the Contract Documents. When bell and spigot pipe is laid, the bell end of the pipe shall be laid 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
- g) Mechanical Restrained Joint with Gasket

421.07.12.06 Polyvinyl Chloride Pipe

Polyvinyl chloride pipe shall be jointed, as recommended by the manufacturer, using a bell and spigot joint with an elastomeric gasket.

At the end of a day's work, the last pipe shall be blocked as may be required to prevent movement.

421.07.12.07 Polypropylene Pipe

Polypropylene pipe shall be jointed by means of a bell and spigot joint with elastomeric gasket or a coupler joint as recommended by the manufacturer to satisfy the pipe joint specification.

421.07.12.08 Corrugated Aluminum Alloy Structural Plate Pipe

Corrugated aluminum alloy structural plate pipe shall be jointed by means of bolts as recommended by the manufacturer to satisfy the pipe joint specification.

421.07.13 Post Installation Inspection

The post installation inspection of pipe culverts shall be carried out by the Contract Administrator as specified in the Quality Assurance section under the following conditions:

- a) When the total combined pipe sewer length of all pipe sewer tender items is greater than or equal to 500 m; or
- b) If the total pipe sewer length of all pipe sewer tender items is less than 500 m, when at least one sewer pipe run will be constructed with a pipe diameter greater than or equal to 450 mm and is greater than or equal to 50 m in length.

A competent and authorized representative of the Contractor, by completing Form PH-CC-822PIC (Culvert Section), shall certify that all pipe culvert installations, within the highway section identified, have been installed and completed in general conformance with the Contract Documents and are ready for the post installation inspection. Submission of Form PH-CC-822PIC shall be deemed to be the request to the Contract Administrator to have the post installation inspection performed at the certification stage indicated on the form. A separate Form PH-CC-822PIC shall be submitted for each construction season of the Contract to have the post installation inspection apportioned by construction season.

The Contract Administrator, upon approving the request, within five Business Days of receipt of Form PH-CC-822PIC, shall provide notification of the start date of the post installation inspection.

Upon commencement of the post installation inspection, the Contractor shall ensure that construction work shall be discontinued temporarily in the vicinity of a pipe culvert being inspected until the inspection of that pipe culvert has been completed.

421.07.14 Cleaning and Flushing of Pipe Culverts

At least two Business Days prior to the commencement of the post installation inspection, the pipe culverts shall be prepared for inspection by cleaning and flushing. The material from the cleaning and flushing operation shall be managed as specified elsewhere in the Contract.

421.07.15 Clay Seals

Clay seals shall be placed as specified in the Contract Documents and compacted to 95% of the Proctor maximum dry density.

421.07.16 Concrete Appurtenances

Concrete appurtenances shall be constructed as specified in the Contract Documents. Concrete in concrete appurtenances shall be placed according to OPSS 904. Steel reinforcement shall be placed according to OPSS 905. Steel grating shall be installed when specified in the Contract Documents.

421.07.17 Site Restoration

Site restoration shall be according to OPSS 492.

421.07.18 Management of Excess Material

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

421.08 QUALITY ASSURANCE

421.08.01 Acceptance

Acceptance shall be according to this specification, including satisfactory completion of all replacement and remedial actions associated with identified deficiencies.

421.08.02 Post Installation Inspection Procedures

Notwithstanding that inspection for compliance with the Contract Documents will be performed during the Contractor's installation of the pipe culverts, the Contract Administrator shall carry out the post installation inspection on a number of test segments. The number of test segments inspected will account for a minimum of 25% of the total number of pipe culvert installations on the Contract for the purpose of defining the quality of workmanship and acceptability of the pipe culvert installations.

On contracts with less than four pipe culverts, a minimum of one test segment will be inspected.

Selected test segments constructed with rigid pipe materials will be inspected using CCTV, zoom camera or by visual observations. Selected test segments constructed with flexible pipe materials will be inspected using CCTV, zoom camera or by visual observations and shall also be inspected for deflection using a mandrel, laser profiler or by direct measurement.

The Contract Administrator shall randomly select the test segments to be inspected on the Contract. If inspecting in a construction season, the number of test segments selected shall be apportioned across all construction seasons to comprise the total amount of test segments to be inspected.

Selected test segments shall be inspected throughout their entire length.

All CCTV, zoom camera or visual observation operations for the post installation inspection will be performed by a certified NASSCO inspector. The certified NASSCO inspector will be responsible to carry out all mandrel, laser profiling or direct measurement operations on flexible pipe culvert installations.

The Contractor may be present during the inspection operations.

Pipe culverts that are to be installed in a preloaded or surcharged condition as specified in the Contract Documents will not be selected as a test segment and will not be subject to payment adjustments. However, these pipe culverts may be subject to a post installation inspection should poor performance and/or service arise after installation. Upon assessment of the post installation inspection submission, any repair or replacement issues shall be dealt with on a case by case basis.

421.08.03 Post Installation Inspection Assessments

The Contract Administrator will assess the post installation inspection submissions for each test segment inspected quantifying the pipe condition statuses as per the pipe condition codes shown in Table 2.

Within 20 Business Days of receipt of Form PH-CC-822PIC, the Contract Administrator shall, for all test segments inspected, provide the Contractor, with copies of all test segment post installation inspection submissions and assessments. This will serve as notification to the Contractor if further action, based on the test segments' pipe condition statuses, is required.

421.08.04 Replacement and Repair

421.08.04.01 Replacement

All individual pipe lengths and/or joints in a test segment assessed with a "Reject" Pipe Condition status shall be replaced by the Contractor by installing new pipe lengths, service connections and/or joints as required.

The Contract Administrator shall, upon written notification from the Contractor that replacement operations have been completed, perform a replacement post installation inspection of all test segments where pipe lengths and/or joints have been replaced and will assess the test segments' pipe condition statuses based on the replacement post installation inspection.

421.08.04.02 Repair

All individual pipe lengths and/or joints in a test segment assessed with a "Repair" Pipe Condition status shall be repaired by the Contractor.

Table 1 lists Owner accepted repair methods and pipe material application that may be used.

The Contractor shall submit a repair proposal to the Contract Administrator within five Business Days after receipt of the test segments' post installation inspection submissions and assessments. The Contract Administrator will review the repair proposal within three Business Days.

Upon approval by the Contract Administrator, the Contractor shall carry out the repairs of the pipe lengths and/or joints in the test segments in accordance with the approved repair proposal.

All repair methods, measures and materials used shall be documented.

The Contract Administrator shall, upon written notification from the Contractor that repair operations have been completed, perform a follow up repair inspection on the pipe lengths and/or joints in the test segments that have been repaired to confirm that the repairs have been made by the Contractor as approved.

Notwithstanding where a test segment or portion of the test segment has been assessed by the Contract Administrator with a "Repair" Pipe Condition status and upon attempting to implement the approved repair proposal, the Contractor determines that the proposed repair measures cannot repair the test segment or portion of the test segment; the test segment or portion of the test segment shall be replaced by the Contractor.

The Contract Administrator shall, upon written notification from the Contractor that replacement operations have been completed, perform a replacement post installation inspection of the test segment in its entirety upon completion of the replacement of the test segment or portion of the test segment and will assess the test segments' pipe condition statuses based on the replacement post installation inspection.

421.08.05 Acceptance

A pipe culvert tender item shall be accepted based on the post installation inspection assessment of selected test segments for that pipe culvert tender item. Additional test segments shall be added as described elsewhere in this specification.

Inspected test segments shall be accepted or not accepted as follows:

Individual test segments or portions of a test segment and/or the joints in a test segment that received no Pipe Condition Code are assessed with an Acceptable Pipe Condition rating, and are not subject to price adjustment.

Individual test segments or portions of a test segment and/or the joints in a test segment that received a Repair Pipe Condition rating, and where the Contract Administrator has confirmed that the Contractor has performed the repairs using non-intrusive repair methods, are deemed acceptable and shall be upgraded to a final Acceptable Pipe Condition rating, and as such are not subject to a price adjustment.

If there are more than 2 repair deficiencies per linear metre or a common repair deficiency is found on 15% or more of the pipe lengths or joints in the test segments inspected where non-intrusive repair measures were used to perform the repairs, the Contract Administrator shall randomly select, at a minimum, an equivalent amount of additional test segments for the post installation inspection.

Individual test segments or portions of a test segment and/or the joints in a test segment that received a Threshold Pipe Condition rating are acceptable, however, are subject to a price adjustment.

If there are more than 2 threshold deficiencies per linear metre or a common threshold deficiency is found on 25% or more of the pipe lengths and/or joints in the test segments inspected, the Contract Administrator shall randomly select, at a minimum, an equivalent amount of additional test segments for the post installation inspection.

Individual test segments or portions of a test segment and/or the joints in a test segment that received a Repair Pipe Condition rating, and where the Contract Administrator has confirmed that the Contractor has performed the repairs using intrusive repair methods, are deemed to be adequate and the entire test segment shall be upgraded to a final Repaired Pipe Condition rating, however, is subject to a price adjustment.

If repair deficiencies were found and intrusive measures were used to repair an individual test segment or portions of test segments, the Contract Administrator shall randomly select, at a minimum, an equivalent amount of additional test segments for the post installation inspection.

Individual test segments or portions of a test segment and/or joints in a test segment that received a Reject Pipe Condition rating are not acceptable.

Of the individual test segments or portions of a test segment and/or the joints in the test segments inspected, if 10% or more of the test segments and/or joints received a Reject Pipe Condition rating, the Contract Administrator shall randomly select, at a minimum, an equivalent amount of additional test segments for the post installation inspection.

421.08.06 Referee Testing

The Contractor may request referee testing on individual test segments or portions of a test segment that received a "Repair", "Reject" or "Threshold" Pipe Condition Status.

Referee testing may only be invoked within five Business Days of the Contractor receiving copies of the test segments' post installation inspection submissions and assessments.

Referee testing shall be done through the following procedure:

- a) The Contractor shall identify the assessments of individual test segments or portions of any test segments that they disagree with;
- b) The Contract Administrator shall arrange for a referee post installation inspection to be performed by an independent NASSCO certified, third party inspector using the same inspection criteria, type of

equipment and techniques as was used for the original post installation inspection on the test segments under disagreement;

- c) The Contract Administrator shall assess the referee post installation inspection submission, which replaces the original post installation inspection submission, for each test segment or portions of test segments under disagreement which will then be binding on both parties; and
- d) The Contract Administrator will provide the Contractor with copies of the test segment referee post installation inspection submissions and assessments which will serve as notification to the Contractor if further action, based on the pipe condition statuses, is required.

421.08.07 Final Pipe Condition Assessment Rating

The Contract Administrator shall assign final Pipe Condition Assessment Ratings (PCAR) as follows:

A PCAR of "R" is assigned to those test segments that, either in part or in whole, initially received a Repair Pipe Condition Status and have been upgraded to a Repaired Pipe Condition Status;

and for the remaining test segments:

A PCAR of "A" is assigned to the portion of the remaining test segments length that received an Acceptable Pipe Condition Status; and

A PCAR of "T" is assigned to the portion of the remaining test segments length that received a Threshold Pipe Condition Status.

421.09 MEASUREMENT FOR PAYMENT

421.09.01 Actual Measurement

421.09.01.01 Pipe Culverts Non-Circular Pipe Culverts Pipe Culvert Extensions Non-Circular Pipe Culvert Extensions

Measurement of pipe culverts, non-circular pipe culverts, pipe culvert extensions, and non-circular pipe culvert extensions shall be along the horizontal length of the pipe in metres, from one end of the pipe or pipe end section to the other end of the pipe or the other pipe end section. When the grade of the pipe culvert is 10% or greater, the above measurement shall then be of the slope length.

421.09.01.02 Concrete Appurtenances

Measurement for concrete appurtenances shall be by volume in cubic metres for the volume of concrete placed. Alternatively, concrete appurtenances may be a lump sum item.

421.09.01.03 Clay Seal

Measurement for clay seal shall be by volume in cubic metres for the volume of clay placed. Alternatively, clay seal may be a lump sum item.

421.09.02 Plan Quantity Measurement

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

421.10**BASIS OF PAYMENT****421.10.01**

"size, type, class" Pipe Culverts - Item
"size, type, class" Non-Circular Pipe Culverts - Item
"size, type, class" Pipe Culvert Extensions - Item
"size, type, class" Non-Circular Pipe Culvert Extensions - Item
Clay Seal - Item
Concrete Appurtenances - Item

Payment at the Contract price for the above tender items shall be full compensation for all Labour, Equipment, and Material to do the work, subject to the payment adjustments as specified in this specification.

Costs for the replacement and/or repair of test segments including but not limited to the associated costs for the reinstatement of the highway structure and all ancillary features previously constructed above the test segments shall be at the Contractor's expense at no additional cost to the Owner. Costs for any delays associated with the repair and/or replacement of the test segments and the reinstatement of the highway structure and all ancillary features previously constructed above the test segments shall also be at the Contractor's expense.

The cost of traffic control for the post installation inspection shall be at the Contractor's expense at no additional cost to the Owner.

The cost for inspection of additional test segments in the post installation inspection, follow up repair inspection and/or replacement post installation inspection, including traffic control, according to the Acceptance of Pipe Culverts clause shall be at the Contractor's expense at no additional cost to the Owner.

The cost of referee post installation inspection according to the Referee Testing clause shall:

- a) Where the assessment of the referee post installation inspection confirms the original pipe condition status, be borne by the Contractor; or
- b) Where the assessment of the referee post installation inspection upgrades the original pipe condition status, be borne by the Owner; or
- c) Where the assessment of the referee post installation inspection upgrades a portion of the original pipe condition status, be apportioned between the Contractor and the Owner based on the final upgraded and confirmed pipe proportions respectively.

421.10.02**Price Adjustment Factors**

Price Adjustment Factors (PAF) for each PCAR is noted as follows:

PCAR of "A" is subject to a PAF equal to 1;

PCAR of "R" is subject to a PAF equal to 0.75; and

PCAR of "T" is subject to a PAF equal to 0.85.

421.10.02.01**Application to Pipe Culvert Tender Items**

A Weighted Price Adjustment Factor (WPAF) is calculated for each pipe culvert tender item that had test segments inspected and is applied against that pipe culvert tender item only. Each pipe culvert tender item that had test segments inspected will have a unique WPAF.

Any test segments with a PCAR of "R" are price adjusted separately as described in Application to Repaired Test Segments clause.

The WPAF for a pipe culvert tender item is calculated using the total pipe length of those remaining test segments that have PCAR of "A" and "T" only.

The Contract Administrator shall calculate the WPAF for a pipe culvert tender item based on the "A" and "T" portions of the remaining test segments lengths, as follows:

WPAF =

$$\frac{\text{PAF(A)} \times \text{"A" portion of remaining test segments' length} + \text{PAF(T)} \times \text{"T" portion of remaining test segments' length}}{\text{Total pipe length of remaining test segments}}$$

This WPAF shall be applied to determine the payment adjustment for the tender item quantity minus the total quantity of test segments in that tender item that have a PCAR of "R".

421.10.02.02 Application to Repaired Test Segments

This individual WPAF is applied to all test segments that are rated "R". A separate WPAF is calculated for each test segment that is rated "R" within a pipe culvert tender item.

The Contract Administrator shall calculate the unique WPAF for each test segment with an "R" rating based on the applicable "A", "R" and "T" ratings as follows:

WPAF =

$$\frac{\text{PAF (A)} \times \text{test segment length rated "A"} + \text{PAF (R)} \times \text{test segment length rated "R"} + \text{PAF (T)} \times \text{test segment length rated "T"}}{\text{Total repaired test segment length}}$$

This WPAF shall be applied to determine the payment adjustment for the repaired test segments in that tender item.

421.10.02.03 Payment Adjustment for Pipe Culverts

Tender item payment adjustments shall be applied only to inspected pipe culvert tender items and associated repaired test segments within the highway section as identified on Form PH-CC-822PIC.

Tender item payment adjustments in the current construction season are not subject to any WPAF as may have been determined through the post installation inspection portion or a referee post installation inspection from previous construction seasons for the same tender item.

To calculate the payment adjustment for an inspected tender item excluding the repaired test segments in the tender item, the following formula using the unique WPAF applicable to the tender item shall be used:

$$\text{Pay. Adjust.} = (\text{Quantity Installed} - \text{Repaired Test Segments Quantity}) \times \text{Contract Price} \times (\text{WPAF} - 1.00)$$

A payment adjustment shall be calculated separately for each tender item that had test segments inspected.

To calculate the payment adjustment for repaired test segments in a tender item, the following formula using the unique WPAF applicable to the repaired test segment shall be used:

$$\text{Pay. Adjust.} = \text{Repaired Test Segment Quantity} \times \text{Contract Price} \times (\text{WPAF} - 1.00)$$

A payment adjustment shall be calculated separately for each repaired test segment that has been assessed with a different WPAF or is from a different tender item. Repaired test segments will be grouped only if they are from the same tender item and have the same WPAF.

When the payment adjustment is zero, there is no payment change. When the payment adjustment is negative, it is a payment reduction.

**Table 1
Accepted Repair Methods**

Repair Method Impact	Repair Method	Pipe Material Application	Repair Method Description
Non-intrusive	Epoxy injection	Concrete	Filling entire fracture with epoxy material to seal against leakage
	High pressure chemical grout	Concrete	Pumping chemical grout into entire fracture to fill the void(s) behind the pipe wall to preserve the structural integrity of the pipe and seal against leakage
	Patching	Concrete	Filling spalled or chipped pipe wall areas with concrete material to prevent early exposure of reinforcing steel bars
	Re-rounding	Steel, HDPE or PVC	Reinstating a flexible pipe to the accepted construction tolerance or Owner acceptance limits
Intrusive	Fold and form	Concrete	Placement of a length of softened pipe material into a pipe installation and expanding to "fit" the inner dimensions of the deficient pipe in order to seal against leakage and maintaining 90% of original flow area.
	Lining	Concrete	Insertion of a short length of smaller pipe into a larger gravity pipe installation and sealing the area between the pipes with grout to provide structural integrity and seal against leakage and maintaining 90% of original flow area.
	Internal sleeve	Concrete	Insertion of a complete smaller gravity pipe installation into a larger gravity pipe installation and sealing the area between the pipes with grout to provide structural integrity seal against leakage and maintaining 90% of original flow area.

Table 2
Gravity Pipe Codes and Associated Pipe Condition Status

Pipe Condition Status Assessment		Threshold □	Repair ■	Reject ■	Not Applicable -		
Pipe Condition Codes	Pipe Code Description and Attributes	Rigid Pipe Applications			Flexible Pipe Applications		
		Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)	Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)
B	Broken pipe has noticeable displacement of cracked pipe wall segments where the breaks show half the pipe wall thickness or greater for thick walled pipe or there is clear visible separation between pipe wall segments for thin (< 8.0 mm) walled pipe	■	■	■	■	■	■
CC	Circumferential crack is visible and apparent but crack edges are not visibly open and the crack spans more than 1 but less than 2 clock reference segments (i.e. between 1 to 3 o'clock)	□	□	□	-	-	-
	Circumferential crack is visible and apparent but crack edges are not visibly open and the crack spans 3 or more clock reference segments (i.e. greater than 1 to 4 o'clock)	■	■	■	-	-	-
	Circumferential crack is visible and apparent but crack edges are not visibly open	-	-	-	■	■	■
CL	Longitudinal crack is visible and apparent but crack edges are not visibly open and the crack is > 1/3 and < 1/2 of individual pipe length	□	□	□	-	-	-
	Longitudinal crack is visible and apparent but crack edges are not visibly open and the crack is > 1/2 of individual pipe length	■	■	■	-	-	-
	Longitudinal crack is visible and apparent but crack edges are not visibly open	-	-	-	■	■	■
CM	Multiple cracks (CC, CL and CS) are several cracks that are visible and apparent but crack edges are not visibly open	■	■	■	■	■	■

Table 2 Gravity Pipe Codes and Associated Pipe Condition Status							
Pipe Condition Status Assessment		Threshold □	Repair □	Reject ■	Not Applicable -		
Pipe Condition Codes	Pipe Code Description and Attributes	Rigid Pipe Applications			Flexible Pipe Applications		
		Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)	Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)
CS	Spiral crack is visible and apparent but crack edges are not visibly open and the crack is > 1/3 and < 1/2 of individual pipe length	□	□	□	-	-	-
	Spiral crack is visible and apparent but crack edges are not visibly open and the crack is > 1/2 of individual pipe length	■	■	■	-	-	-
CS	Spiral crack is visible and apparent but crack edges are not visibly open	-	-	-	■	■	■
FC	Circumferential fracture is a crack where the edges are visibly separated with an opening width that is < 0.6 mm and is < 1 clock reference segments (i.e. between 1 to 2 o'clock)	□	□	□	-	-	-
	Circumferential fracture is a crack where the edges are visibly separated with an opening width that is < 0.6 mm and is > 1 and < 2 clock reference segments (i.e. between 1 to 3 o'clock)	▣	▣	▣	-	-	-
	Circumferential fracture is a crack where the edges are visibly separated with an opening width that is < 0.6 mm and is more than 2 clock reference segments (i.e. greater than 1 to 3 o'clock)	■	■	■	-	-	-
	Circumferential fracture is a crack where the edges are visibly separated with an opening width that is > 0.6 mm and > 1 and < 2 clock reference segments (i.e. between 1 to 3 o'clock)	▣	▣	▣	-	-	-
	Circumferential fracture is a crack where the edges are visibly separated with an opening width that is > 0.6 mm and is more than 2 clock reference segments (i.e. greater than 1 to 3 o'clock)	■	■	■	-	-	-
	Circumferential fracture is a crack where the edges are visibly separated	-	-	-	■	■	■

Table 2 Gravity Pipe Codes and Associated Pipe Condition Status							
Pipe Condition Status Assessment		Threshold □	Repair ◻	Reject ■	Not Applicable -		
Pipe Condition Codes	Pipe Code Description and Attributes	Rigid Pipe Applications			Flexible Pipe Applications		
		Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)	Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)
FL	Longitudinal fracture is a crack where the edges are visibly separated with an opening width that is < 0.6 mm and the crack is > 1/3 and < 1/2 of individual pipe length	□	□	□	-	-	-
	Longitudinal fracture is a crack where the edges are visibly separated with an opening width that is < 0.6 mm and the crack is > 1/2 of individual pipe length	■	■	■	-	-	-
	Longitudinal fracture is a crack where the edges are visibly separated with an opening width that is > 0.6 mm and the crack is > 1/3 and < 1/2 of individual pipe length	◻	◻	◻	-	-	-
FL	Longitudinal fracture is a crack where the edges are visibly separated with an opening width that is > 0.6 mm and the crack is > 1/2 of individual pipe length	■	■	■	-	-	-
	Longitudinal fracture is a crack where the edges are visibly separated	-	-	-	■	■	■
FM	Multiple fracture (FC, FL and FS) are several cracks where the edges are visibly separated	■	■	■	■	■	■

Table 2 Gravity Pipe Codes and Associated Pipe Condition Status									
Pipe Condition Status Assessment		Threshold □	Repair ▣	Reject ■	Not Applicable -				
Pipe Condition Codes	Pipe Code Description and Attributes			Rigid Pipe Applications			Flexible Pipe Applications		
				Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)	Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)
FS	Spiral fracture is a crack where the edges are visibly separated with an opening width that is < 0.6 mm and the crack is > 1/3 and < 1/2 of individual pipe length			□	□	□	-	-	-
	Spiral fracture is a crack where the edges are visibly separated with an opening width that is < 0.6 mm and the crack is > 1/2 of individual pipe length			■	■	■	-	-	-
	Spiral fracture is a crack where the edges are visibly separated with an opening width that is > 0.6 mm and the crack is > 1/3 and < 1/2 of individual pipe length			▣	▣	▣	-	-	-
	Spiral fracture is a crack where the edges are visibly separated with an opening width that is > 0.6 mm and the crack is > 1/2 of individual pipe length			■	■	■	-	-	-
	Spiral fracture is a crack where the edges are visibly separated			-	-	-	■	■	■
H	Visible hole in the pipe sewer wall			■	■	■	■	■	■
D	Deformed Pipe determined by Visual techniques	right or left side only > 5% and > 2 clock references (i.e. greater than 1 to 3 o'clock)		-	-	-	■	■	■
		upper or lower left or right quadrants > 5% and > 2 clock references (i.e. greater than 1 to 3 o'clock)		-	-	-	■	■	■
D	Deformed Pipe determined by deflection measurements	< 750 mm	> 5% and < 7.5%	-	-	-	□	□	□
			> 7.5% and < 10%	-	-	-	▣	▣	▣
			> 10%	-	-	-	■	■	■
		> 750 mm	> 5% and < 7.5%	-	-	-	▣	▣	▣
			> 7.5%	-	-	-	■	■	■
				-	-	-	■	■	■

Table 2 Gravity Pipe Codes and Associated Pipe Condition Status							
Pipe Condition Status Assessment		Threshold ☐	Repair ☐	Reject ☒	Not Applicable -		
Pipe Condition Codes	Pipe Code Description and Attributes	Rigid Pipe Applications			Flexible Pipe Applications		
		Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)	Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)
DE	Settled deposits in the pipe blocking > 10% of cross sectional area, regardless of material composition	☐	☐	☐	☐	☐	☐
DI	Dropped invert of individual pipe lengths or at end of sewer run or culvert	☒	☒	☒	☒	☒	☒
JDM	Pipe lengths have slid apart at the joint with a separation distance between pipe length edges that is > 50 mm and < 75 mm, however, there is no opening where the pipe fill material is visible	☐	☐	☐	☐	☐	☐
JDL	Pipe lengths have slid apart at the joint with a separation distance between pipe length edges that is > 75 mm, however, there is no opening where the pipe fill material is visible	☒	☐	☐	☒	☐	☐
LL or LR	Line deviations left or right by > 5 and < 10 degrees as applied to straight pipe culvert installations	☐	☐	☐	☐	☐	☐
	Line deviations left or right by > 10 degrees and < 20 degrees as applied to straight pipe culvert installations	☐	☐	☐	☐	☐	☐
	Line deviations left or right by > 20 degrees as applied to straight pipe culvert installations	☒	☒	☒	☒	☒	☒
LD or LU	Line deviations up or down by > 5 and < 10 degrees as applied to straight pipe culvert installations	☐	☐	☐	☐	☐	☐
	Line deviations up or down by > 10 degrees as applied to straight pipe culvert installations	☒	☒	☒	☒	☒	☒
OB	An obstruction is apparent in the pipe and is not a feature that has been built into or inserted into the pipe	☐	☐	☐	☐	☐	☐
OJM	Pipe lengths have slid apart at the joint displaying an opening where pipe fill material is visible and the opening width is > 50 mm and < 75 mm	☒	☐	☐	☒	☐	☐

Table 2 Gravity Pipe Codes and Associated Pipe Condition Status							
Pipe Condition Status Assessment		Threshold ☐	Repair ☐	Reject ☒	Not Applicable -		
Pipe Condition Codes	Pipe Code Description and Attributes	Rigid Pipe Applications			Flexible Pipe Applications		
		Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)	Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)
OJL	Pipe lengths have slid apart at the joint displaying an opening where pipe fill material is visible and the opening width is > 75 mm	☒	☐	☐	☒	☐	☐
IS	Infiltration seeping is the slow ingress of water into the pipe through a fracture with crack width opening < 0.6 mm but there are no visible drips	☐	☐	☐	☒	☒	☒
IS	Infiltration seeping is the slow ingress of water into the pipe through a fracture with crack width opening > 0.6 mm but there are no visible drips	☐	☐	☐	☒	☒	☒
	Infiltration seeping is the slow ingress of water into the pipe through a joint (JDM) but there are no visible drips	☒	☐	☐	☒	☐	☐
	Infiltration seeping is the slow ingress of water into the pipe through a joint (JDL) but there are no visible drips	☒	☐	☐	☒	☐	☐
ID	Infiltration dripping is water dripping into the pipe through a fracture with crack width opening < 0.6 mm but not in a continuous flow	-	-	-	☒	☒	☒
	Infiltration dripping is water dripping into the pipe through a fracture with crack width opening > 0.6 mm but not in a continuous flow	☐	☐	☐	☒	☒	☒
ID	Infiltration dripping is water dripping into the pipe through a joint (JDM) but not in a continuous flow	☐	☐	☐	☐	☐	☐
	Infiltration dripping is water dripping into the pipe through a joint (JDL) but not in a continuous flow	☒	☐	☐	☒	☐	☐

Table 2 Gravity Pipe Codes and Associated Pipe Condition Status							
Pipe Condition Status Assessment		Threshold ☐	Repair ☐	Reject ☒	Not Applicable -		
Pipe Condition Codes	Pipe Code Description and Attributes	Rigid Pipe Applications			Flexible Pipe Applications		
		Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)	Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)
IR	Infiltration running is water running into the pipe through a fracture with crack width opening < 0.6 mm and a continuous flow is visible	☐	☐	☐	☒	☒	☒
	Infiltration running is water running into the pipe through a joint and a continuous flow is visible	☐	☐	☐	☐	☐	☐
IG	Infiltration gushing is water entering the pipe through a fracture or joint under pressure but may not necessarily be a heavy flow	☒	☒	☒	☒	☒	☒
SWM	Surface Damage to pipe coating by abrasion, wear or other installation related damages on galvanized, aluminized Type II and/or polymer laminated steel pipes where the damage area's linear measurement is < 10% of individual pipe length and the damage area's widest width measurement is < 2 clock segments (i.e. between 1 to 3 o'clock)	-	-	-	☐	☐	☐
SWL	Surface Damage to pipe coating damage by abrasion, wear or other installation related damages on galvanized, aluminized Type II and/or polymer laminated steel pipes where the damage area's linear measurement is > 10% of individual pipe length and the damage area's widest width measurement is > 2 clock segments(i.e. greater than 1 to 3 o'clock)	-	-	-	☒	☒	☒
SWM	Surface wear in the context of abrasion, wear or other installation related damages to the inner surface of HDPE and PVC pipe products where the damage area's linear measurement is < 10% of individual pipe length and the damage area's widest width measurement is < 2 clock segments (i.e. between 1 to 3 o'clock)	-	-	-	☐	☐	☐

Table 2 Gravity Pipe Codes and Associated Pipe Condition Status							
Pipe Condition Status Assessment		Threshold □	Repair □	Reject ■	Not Applicable -		
Pipe Condition Codes	Pipe Code Description and Attributes	Rigid Pipe Applications			Flexible Pipe Applications		
		Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)	Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)
SWL	Surface wear in the context of abrasion, wear or other installation related damages to the inner surface of HDPE and PVC pipe products where the damage area's linear measurement is > 10% of individual pipe length and the damage area's widest width measurement is > 2 clock segments (i.e. greater than 1 to 3 o'clock)	-	-	-	■	■	■
SSM	Surface Damage in the context of spalling where inner surface is splintered or chipped where total area coverage is > 0.5 and < 1.0 m in length and < 2 clock reference segments in width (i.e. between 1 to 3 o'clock)	■	■	■	-	-	-
SSL	Surface Damage in the context of spalling where inner surface is splintered or chipped where total area coverage is > 1.0 m in length and > 2 clock reference segments in width (i.e. greater than 1 to 3 o'clock)	■	■	■	-	-	-
SR	Sealing ring at the pipe joint is displaced and intruding into the pipe	■	■	□	■	■	□
SRB	Sealing ring at the pipe joint is broken	■	■	□	■	■	□
X	Collapsed Pipe > 50% of cross sectional area lost	■	■	■	■	■	■

*** Note:**

Gravity pipe culvert requirements are as specified in the Pipe Joints column of the Quantities – Pipe Culverts contract sheets. The requirements are:

S for soil tight (replaces N);
F for silt or fines tight (replaces L); and
L for water or leak tight (replaces H).

Pipe Condition Codes are the standard condition classification codes as identified in the Manual of Sewer Condition Classification.



FIGURE 1
CSA Standards
Certification Logo

Appendix 421-A, November 2015

FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

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

Designer Action/Considerations

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR STEEL BEAM GUIDE RAIL AND CABLE GUIDE RAIL

TABLE OF CONTENTS

721.01	SCOPE
721.02	REFERENCES
721.03	DEFINITIONS - Not Used
721.04	DESIGN AND SUBMISSION REQUIREMENTS - Not Used
721.05	MATERIALS
721.06	EQUIPMENT - Not Used
721.07	CONSTRUCTION
721.08	QUALITY ASSURANCE - Not Used
721.09	MEASUREMENT FOR PAYMENT
721.10	BASIS OF PAYMENT

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

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

721.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

721.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 501 Compacting

Ontario Provincial Standard Specifications, Material

OPSS 1350 Concrete - Materials and Production
OPSS 1503 Cable Guide Rail
OPSS 1504 Steel Beam Guide Rail
OPSS 1505 Channel Components for Steel Beam Guide Rail
OPSS 1601 Wood, Preservative Treatment, and Shop Fabrication

Ontario Ministry of Transportation Publications

Ontario Traffic Manual (OTM):
Book 11 - Pavement, Hazard and Delineation Markings

CSA Standards

G164-M92 (R2003) Hot Dip Galvanizing of Irregularly Shaped Articles
O56-10 (R2015) Round Wood Piles

ASTM International

A 36/A 36M-12	Carbon Structural Steel
A 780/A 780M-09	Repair of Damaged and Uncoated Areas of Hot Dip Galvanized Coatings
D 4956-11a	Retroreflective Sheeting for Traffic Control

721.05 MATERIALS

721.05.01 Cable Guide Rail

Guide rail cable, fittings, cable clamps and nails, and steel sections for anchor blocks shall be according to OPSS 1503.

Guide rail posts shall be clean peeled according to CAN/CSA O56, and according to OPSS 1601.

Precast concrete anchor blocks shall be according to OPSS 1503.

Reflectorized strips on 0.5 mm thick aluminum sheet shall be according to OTM Book 11 and as specified in the Contract Documents.

721.05.02 Steel Beam Guide Rail

Steel beam guide rail shall be according to OPSS 1504.

Channel components shall be according to OPSS 1505.

Wooden posts and blocks shall be according to OPSS 1601.

Plastic blocks shall be as specified in the Contract Documents.

Steel sleeves and spacer tubes used in transition treatments to concrete structures shall be fabricated from Schedule 40 galvanized steel pipe.

Steel posts, sleeves, and spacer tubes shall be hot dip galvanized after fabrication according to CSA G164.

Steel posts shall be according to ASTM A 36.

Reflectors shall have a minimum reflective surface of 100 x 100 mm; high intensity retroreflective sheeting according to ASTM D 4956, Type VII; colour according to OTM Book 11; and flexibility to bend 90 degrees from vertical and self restore.

721.05.03 Fabricated Steel Bases

Fabricated steel bases shall be according to OPSS 1503.

721.05.04 Concrete

Concrete shall be according to OPSS 1350 with a nominal minimum 28-Day compressive strength of 30 MPa.

721.07 CONSTRUCTION

721.07.01 General

Guide rail systems shall be installed plumb and to the alignment and grade as specified in the Contract Documents, regardless of the material encountered.

Tops of wooden posts shall be cut as specified in the Contract Documents and treated with two coats of 2% copper naphthenate wood preservative. Field applied wood preservative that comes in contact with any galvanized components shall be removed immediately.

Acceptable material from posthole or anchor block excavation shall be used as backfill around posts and compacted according to OPSS 501.

When required, fabricated steel bases shall be installed level and square to the centreline of the roadway.

Cut ends, field drilled holes, and damaged areas of hot dip galvanized coatings on any galvanized component shall be repaired according to ASTM A 780.

Flame cutting shall not be permitted.

721.07.02 Cable Guide Rail

721.07.02.01 Installation

Cable guide rail shall be installed as specified in the Contract Documents.

Wooden posts shall be installed to the specified depth with the larger end of the post in the ground.

Cable shall be attached to guide rail posts using cable clamps and nail fasteners.

Cable mounting height shall be measured from the top of final shoulder grade at the post face. Cable height shall be adjusted to provide a smooth installation.

Cables shall be tensioned so that the sag between posts shall be a maximum of 6 mm.

Cable splices occurring on the same cable shall be spaced a minimum length of 15 m apart.

There shall be only one cable splice per panel, regardless of the number of cables in the system.

721.07.02.02 Anchor Blocks

Precast or cast-in-place cubical or cylindrical anchor blocks shall be installed as specified in the Contract Documents, regardless of the material encountered.

In porous or crumbly soil, forms for cast-in-place anchors shall be used to prevent contamination of the concrete. Forms may be left in place or removed.

Earth backfill and granular materials shall be compacted according to OPSS 501.

721.07.02.03 Reflectorized Strips

Reflectorized strips shall be installed:

- a) starting at the second post from the approach end.
- b) at a maximum interval of every fifth post on tangent.
- c) at a maximum interval of every third post on curves.
- d) ending on the second to last post.

The reflectorized strip shall be fastened on posts as specified in the Contract Documents using two 50 mm aluminum nails.

721.07.02.04 Adjust Cable Guide Rail

Cable guide rail shall be adjusted at locations as specified in the Contract Documents.

Cable guide rail adjustment shall be as specified in the Contract Documents and include:

- a) the removal of the following:
 - i. staples and spacers or cable clamps and nails
 - ii. reflectorized strips
 - iii. cables as salvage
- b) the installation of the following:
 - i. salvaged cables
 - ii. new cable clamps and nails
 - iii. new reflectorized strips

To facilitate cable tensioning, one new turnbuckle assembly shall be installed on each cable between each set of adjacent anchor blocks. Cables shall be tensioned so that the sag between posts shall be a maximum of 6 mm.

721.07.02.05 Cable Guide Rail Post Replacement

Existing cable guide rail posts shall be removed and replaced with new cable guide rail posts at locations as specified in the Contract Documents and installed as specified in the Cable Guide Rail Installation clause. The Contractor shall confirm the locations with the Contractor Administrator prior to commencing the removal of existing posts.

721.07.03 Steel Beam Guide Rail

721.07.03.01 Installation

Steel beam guide rail shall be installed as specified in the Contract Documents.

Each steel beam guide rail installation may incorporate either steel posts with either plastic or routed wooden blocks or wooden posts with wooden blocks, but not both. Wooden posts shall only be permitted within steel post installations when wooden posts are specified for guide rail end treatments. Extension of an existing wooden post installation using steel posts shall only be permitted when the extension length is greater than 100 m.

Different types of plastic and wooden blocks shall not be used together within a steel beam guide rail installation.

When a transition to a rigid obstacle is required, the offset block for the channel may be either wood or a pipe sleeve over the connecting bolt. The pipe sleeve shall be 89 mm OD galvanized steel pipe cut to the required length.

Backup plates, steel spacer tubes, and pipe sleeves shall be installed as specified in the Contract Documents.

All joints shall be lapped in the direction of traffic.

Bolts shall be tightened to 100 N·m. Bolts for wooden post installations shall be field cut as required to maintain a maximum protrusion of 10 mm beyond the nut. The cut end of the bolt shall be ground smooth with all sharp edges and burrs removed.

Steel beam guide rail mounting heights shall be measured vertically from the top of the steel beam guide rail.

Steel beam guide rail without channel mounting heights shall be within the following ranges:

- a) 685 to 760 mm during construction and seasonal shutdown.
- b) 685 to 735 mm upon completion of the work.

Steel beam guide rail with channel mounting heights shall be within the following ranges:

- a) 685 to 785 mm during construction and seasonal shutdown.
- b) 735 to 785 mm upon completion of the work.

Where curb with gutter is required, steel beam guide rail mounting heights shall be measured:

- a) Vertically at face of steel beam guide rail, when face of steel beam guide rail is more than 300 mm beyond the gutter line.
- b) Vertically at the gutter line, when face of steel beam guide rail is 300 mm or less beyond the gutter line.

721.07.03.02 Reflectors

Reflectors shall be installed:

- a) starting at the fifth post from the approach end of a steel beam guide rail end treatment.
- b) at a maximum interval of every tenth post on tangent.
- c) as specified in OTM Book 11, Table 4, on curves.
- d) ending on the last post of the steel beam guide rail installation.
- e) on the posts at the four adjacent steel beam guide rail splices at the approach and leaving end of structures.

The reflector shall be fastened to the post using adhesives, bolts and nuts, or screws with reflective surfaces clear above the top of the posts. One-sided reflectors shall be installed on divided highways and two-sided reflectors shall be installed on undivided highways.

721.07.03.03 Steel Beam Guide Rail Structure Connections

Steel beam guide rail shall be connected to new or existing structure walls as specified in the Contract Documents.

721.07.03.04 Adjust Steel Beam Guide Rail

Steel beam guide rail shall be adjusted at locations as specified in the Contract Documents.

Steel beam rail elements, channel elements, and offset blocks shall be disassembled from the posts. Post bolts, washers, nuts and existing steel offset blocks shall be removed and disposed of as specified in the Contract Documents.

Steel beam rail elements, channel elements, wooden offset blocks, and plastic offset blocks, shall be salvaged for reinstallation. Washers from the front face of the existing steel beam guide rail shall not be reinstalled.

Salvaged steel beam rail elements, channel elements, and wooden or plastic offset blocks shall be reinstalled within the mounting height ranges as specified in the Steel Beam Guide Rail Installation clause using new post bolts, washers, and nuts.

For steel post adjustment, the post shall be raised a minimum of 50 mm above the specified height and then driven down to the required depth before the salvaged steel beam guide rail components are reinstalled. When existing steel offset blocks have been removed, new wooden or plastic offset blocks shall be installed. A new hole shall be field punched through the existing post as specified in the Contract Documents.

For wooden post adjustment, a new hole shall be field drilled through the existing post as specified in the Contract Documents. The top of the offset block shall not extend beyond the top of the existing post. When channel elements are being reinstalled, an additional hole shall be field drilled through the existing post as specified in the Contract Documents.

New reflectors shall be supplied and installed as specified in the Reflectors clause. When new reflectors are installed on a wooden post system, the reflector shall be installed on the approach transverse face of the wooden offset block with one edge 12 mm from edge of post.

721.07.04 Management of Excess Material

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

721.09 MEASUREMENT FOR PAYMENT

721.09.01 Actual Measurement

721.09.01.01 Cable Guide Rail

Measurement of cable guide rail shall be by length in metres along the centreline of the system from centre of anchor block to centre of anchor block at each end of an installation. No additions shall be made for the overlapping length of cable at intermediate anchor blocks.

721.09.01.02 Adjust Cable Guide Rail

Measurement of adjust cable guide rail shall be by length in metres along the centreline of the system from centre of anchor block to centre of anchor block at each end of an installation. No additions shall be made for the overlapping length of cable at intermediate anchor blocks.

721.09.01.03 Cable Guide Rail Post Replacement

For measurement purposes, a count shall be made of the number of cable guide rail post replacement installed.

721.09.01.04 Anchor Blocks

For measurement purposes, a count shall be made of the number of anchor blocks installed.

**721.09.01.05 Single Rail Steel Beam Guide Rail
Single Rail Steel Beam Guide Rail with Channel
Double Rail Steel Beam Guide Rail**

Measurement of steel beam guide rail shall be by length in metres along the centreline of the system from end to end of each steel beam guide rail installation. The length includes all treatments, transitions, and connections, but does not include terminal systems.

**721.09.01.06 Adjust Steel Beam Guide Rail, Wooden Posts
Adjust Steel Beam Guide Rail, Steel Posts
Adjust Steel Beam Guide Rail, Steel Posts with Steel Offset Blocks**

Measurement of adjust steel beam guide rail shall be by length in metres along the centreline of the adjusted system from end to end of each steel beam guide rail installation. The length includes all treatments, transitions, connections, and terminal systems.

721.09.01.07 Steel Beam Guide Rail Structure Connections

For measurement purposes, a count shall be made of the number of steel beam guide rail structure connections installed.

721.09.02 Plan Quantity Measurement

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

721.10 BASIS OF PAYMENT

**721.10.01 Cable Guide Rail - Item
Adjust Cable Guide Rail - Item
Cable Guide Rail Post Replacement - Item
Anchor Blocks - Item
Single Rail Steel Beam Guide Rail - Item
Single Rail Steel Beam Guide Rail with Channel - Item
Double Rail Steel Beam Guide Rail - Item
Adjust Steel Beam Guide Rail, Wooden Posts - Item
Adjust Steel Beam Guide Rail, Steel Posts - Item
Adjust Steel Beam Guide Rail, Steel Posts with Steel Offset Blocks - Item
Steel Beam Guide Rail Structure Connections - Item**

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

When there is not a separate tender item for steel beam guide rail structure connections, payment at the Contract price for single rail steel beam guide rail with channel shall include full compensation for all labour, Equipment, and Material to do the work of connecting steel beam guide rail to a structure.

Costs associated with any required repairs or removal and replacement of defective materials shall be the Contractor's responsibility at no additional cost to the Owner.

Appendix 721-A, November 2015
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

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

Designer Action/Considerations

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR ENERGY ATTENUATORS

TABLE OF CONTENTS

723.01	SCOPE
723.02	REFERENCES
723.03	DEFINITIONS
723.04	DESIGN AND SUBMISSION REQUIREMENTS
723.05	MATERIALS
723.06	EQUIPMENT - Not Used
723.07	CONSTRUCTION
723.08	QUALITY ASSURANCE - Not Used
723.09	MEASUREMENT FOR PAYMENT
723.10	BASIS OF PAYMENT

APPENDICES

723-A	Commentary
--------------	-------------------

723.01 SCOPE

This specification covers the requirements for the installation of permanent and temporary energy attenuators and relocation of temporary energy attenuators.

723.01.01 Specification Significance and Use

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

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

723.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

723.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 314	Untreated Granular Subbase, Base, Surface Shoulder, and Stockpiling
OPSS 510	Removal
OPSS 705	Flexible Delineator Posts
OPSS 740	Concrete Barriers
OPSS 904	Concrete Structures

Ontario Provincial Standard Specifications, Material

OPSS 1350	Concrete - Materials and Production
OPSS 1440	Steel Reinforcement for Concrete

Ontario Ministry of Transportation Publications

Ontario Traffic Manual (OTM):
Book 6 - Warning Signs

ASTM International

A 123/A 123M-13	Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
A 325-14	Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
A 780/A 780M-09	Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
D 4956-13	Retroreflective Sheeting for Traffic Control

723.03 DEFINITIONS

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

Dual Duty means a new high exposure energy attenuator that is supplied and installed in a temporary configuration during construction, temporarily relocated as required, and then relocated to its permanent location prior to the end of the Work.

High Exposure means an energy attenuator that is installed in a location where the risk of impact is expected to be high such as in gore areas at exit ramps and express - collector transfers.

Reduced Exposure means a temporary energy attenuator that is installed in a location where the risk of impact is expected to be low. These energy attenuators should be specified in a location where they will be required for short duration of less than four months, are frequently relocated, and where they are not required during seasonal shutdown.

723.04 DESIGN AND SUBMISSION REQUIREMENTS

723.04.01 Design Requirements

The energy attenuator manufacturer shall complete the design of any non-standard details (e.g., a connection or transition to a rigid object other than a concrete barrier or temporary concrete barrier) at locations specified in the Contract Documents.

723.04.02 Submission Requirements

One copy of the manufacturer's installation instructions and Working Drawings shall be submitted to the Contract Administrator.

Installation of the energy attenuator shall not commence until the Contract Administrator has received the copy of the instructions and Working Drawings.

723.04.02.01 Submission Requirements for Non-Standard Details

Three copies of Working Drawings, prepared by the manufacturer, for any non-standard details shall be submitted to the Contract Administrator prior to the commencement of construction. The Working Drawings shall show full details of the materials and installation procedures. An Engineer's seal and signature shall be affixed on the Working Drawings verifying that the drawings are consistent with the Contract Documents. The submission of Working Drawings shall be accompanied by 3 copies of a letter that has been signed by the manufacturer, on company letterhead, summarizing the details of the proposed design.

Installation of the energy attenuator shall not commence until the Contract Administrator has received and accepted the copy of the letters and Working Drawings.

723.05 MATERIALS

723.05.01 General

All supplied system components shall be according to the manufacturer's specifications.

723.05.02 Energy Attenuator Systems

The names of systems acceptable for the Energy Attenuator - Permanent items are shown in Table 1.

The names of systems acceptable for the Energy Attenuator - Temporary items are shown in Table 2.

The Contractor shall have the option of supplying and installing any of these approved systems shown for the appropriate tender item.

723.05.03 Concrete

Concrete for pads and anchor blocks shall be according to OPSS 1350 with a nominal minimum 28-Day compressive strength of 30 MPa.

723.05.04 Steel Reinforcement

Steel reinforcement shall be according to OPSS 1440.

723.05.05 Anchor Bolts

Anchor bolts shall be supplied and installed according to energy attenuator manufacturer recommendations.

723.05.06 Bolts for Connection of BB-BEAT System to Concrete Barrier

Bolts used to connect the BB-BEAT system to the concrete barrier shall be according to ASTM A 325 and shall be hot dip galvanized according to ASTM A 123.

723.05.07 U Channel Posts

Posts shall be 2.44 m long perforated steel U channel with 11 mm diameter holes spaced on 50 mm centres, minimum weight of 4.46 kg/m, and hot dip galvanized according to ASTM A 123.

723.05.08 Flexible Delineator Posts

Flexible delineator posts shall be according to OPSS 705. The post colour shall be orange.

723.05.09 Reflective Sheeting

Flexible delineator posts shall be outfitted with high intensity retroreflective sheeting according to ASTM D 4956, Type IV; white colour; and to the dimensions specified in the Contract Documents.

723.05.10 Reuse of Materials

Notwithstanding subsection GC 5.02, Quality of Material, paragraph 01 of the General Conditions of Contract, the reuse of materials is permitted for temporary energy attenuator installations and relocations, provided the components have not been damaged to affect the safety performance of the system.

723.07 CONSTRUCTION

723.07.01 General

Permanent and temporary energy attenuators shall be installed according to manufacturer's instructions at locations specified in the Contract Documents. A reference for energy attenuator Contract Drawing Notation is shown in Table 3.

Energy attenuators shall not be placed on surfaces with a crossfall greater than 6%.

723.07.02 Permanent Installation

723.07.02.01 New Concrete Pads

Levelling and site preparation required for the existing granular base shall be performed prior to placing the concrete pad. The concrete pad shall be constructed as specified in the Contract Documents. Concrete shall be placed, cured, and finished according to OPSS 904.

The granular base below new concrete pads shall be a minimum depth of 150 mm of existing or new Granular A and shall be according to OPSS 314.

723.07.02.02 Existing Concrete Surfaces and Pads

When specified in the Contract Documents, existing 200 mm thick concrete surfaces, pads, or precast pads may be used to support the energy attenuator.

723.07.02.03 Connection of BB-BEAT and QuadTrend Systems to Concrete Barrier

When the BB-BEAT or QuadTrend system is connected to new concrete barrier, the adjacent 4.0 m of concrete barrier shall be according to OPSS 740 and the Contract Documents.

When the BB-BEAT or QuadTrend system is connected to existing concrete barrier, the adjacent 4.0 m of existing concrete barrier shall be removed according to OPSS 510 and a new 4.0 m section of concrete barrier shall be installed according to OPSS 740 and the Contract Documents.

723.07.02.04 Rear Cable Anchor Blocks for QuadTrend Systems

Rear cable anchor blocks shall be as specified in the Contract Documents. In both earth and rock fills, rear cable anchor blocks shall be placed on slopes 3H:1V or flatter. The cable supplied with the unit shall be used to determine the proper location of the rear cable anchor block.

In porous or crumbly soils, forms for cast-in-place anchor blocks shall be used to prevent contamination of the concrete. Forms may be left in place or removed.

The top of the concrete block shall be flush with the embankment slope and the rear cable anchor assembly shall not protrude more than 100 mm above ground.

723.07.02.05 Damage to Galvanizing

Precautions shall be taken to protect galvanizing against damage. Minor abrasions shall be repaired according to ASTM A 780. Components with major abrasions shall be replaced.

The method of repair for any damage shall be approved by the Contract Administrator prior to the commencement of such work.

723.07.02.06 Posts for BB-BEAT Systems

All posts shall be set to the alignment specified in the Contract Documents, regardless of the material encountered. Permissible tolerance for plumb shall be 20 mm maximum over the post length above the ground. The driving of posts shall be accomplished with methods and equipment that leave the posts free of distortion, burring, and any other damage.

All lower end posts shall be installed so that not more than 100 mm is exposed above finished grade.

723.07.03 Temporary Installation

723.07.03.01 Existing Concrete Surface

Existing 200 mm minimum thick concrete surfaces, pads, or precast pads may be used to support the energy attenuator.

723.07.03.02 Asphalt Over Concrete

Existing or new 75 mm minimum thick asphalt over 75 mm minimum thick concrete pavement may be used to support the energy attenuator.

723.07.03.03 Asphalt Over Compacted Granular

Existing or new 150 mm minimum thick asphalt over 150 mm minimum thick compacted granular base may be used to support the energy attenuator. The asphalt shall extend a minimum of 500 mm beyond the anchor bolts.

723.07.03.04 Reduced Exposure

When water filled energy attenuator systems are in use, the temperature shall be monitored on a daily basis. When the temperature is predicted to fall below freezing, antifreeze agents according to manufacturer recommendations shall be added to the water. The use of a water filled energy attenuator system when frozen is not permissible.

Water filled energy attenuator systems shall not be left in place during a seasonal shutdown period without approval from the Contract Administrator. When approval from the Contract Administrator is not granted, water filled energy attenuator systems shall be replaced with another approved energy attenuator listed for the reduced exposure tender item for the duration of the seasonal shutdown period.

Disposal of liquid materials shall be managed according to the Contract Documents.

723.07.03.05 Dual Duty

A new high exposure energy attenuator shall be supplied and installed in a temporary configuration during construction at the locations specified in the Contract Documents.

723.07.03.06 Relocation

Temporary energy attenuators, object markers, oversize snowplow markers, object marker posts, and flexible delineator posts shall be relocated as specified in the Contract Documents, including the removal of existing and installation of new anchor bolts and mounting hardware.

Prior to completion of the Contract, dual duty energy attenuators and associated object markers, oversize snowplow markers, and object marker posts including the replacement of anchor bolts and mounting hardware, shall be relocated to their permanent locations as specified in the Contract Documents and in accordance with the General and Permanent Installation subsections.

723.07.03.07 Permanent and Temporary Concrete Barriers

Temporary concrete barriers shall be modified and installed as specified in the Contract Documents and the modified surfaces shall be smooth. Temporary concrete barriers shall be anchored as specified in the Contract Documents.

Permanent existing concrete barriers shall be modified as specified in the Contract Documents and the modified surfaces shall be smooth.

723.07.04 Delineation

723.07.04.01 Object Markers and Oversize Snowplow Markers

A Wa-33 object marker according to OTM Book 6, a Wz-2 oversize snowplow marker, and galvanized mounting hardware shall be installed at each energy attenuator.

When installed on a paved surface, the object marker and oversize snowplow marker shall be integrally attached to a surface mounted flexible post. The signs and post shall be supplied by the manufacturer as a complete unit. The post shall have the ability to bend 90° from vertical and self-restore after impacts. The minimum outside diameter of the post shall be 60 mm. The post shall be anchored to the pavement according to manufacturer's recommendations.

When installed on a granular surface, the Wa-33 object marker and Wz-2 oversize snowplow marker shall be securely fastened to a U channel post and the post shall be direct buried to a minimum embedment depth of 900 mm.

Posts shall be installed at locations specified in the Contract Documents.

723.07.04.02 Flexible Delineator Posts

Flexible delineator posts shall be installed according to OPSS 705 at locations specified in the Contract Documents.

723.07.05 Management of Excess Material

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

723.09 MEASUREMENT FOR PAYMENT

723.09.01 Actual Measurement

723.09.01.01 Energy Attenuator - Permanent, Narrow Energy Attenuator - Permanent, Wide Energy Attenuator - Permanent, Extra Wide Energy Attenuator - Permanent, Super Wide Energy Attenuator - Permanent, High Exposure Energy Attenuator - Permanent, Single-Sided

For measurement purposes, a count shall be made of the number of complete energy attenuator systems installed.

723.09.01.02 Energy Attenuator - Temporary, Narrow Energy Attenuator - Temporary, Wide Energy Attenuator - Temporary, Extra Wide Energy Attenuator - Temporary, Super Wide

Energy Attenuator - Temporary, Reduced Exposure
Energy Attenuator - Temporary, Dual Duty

For measurement purposes, a count shall be made of the number of complete energy attenuator systems installed and removed, up to the maximum number of systems required to be in place at any one time during the Contract.

723.09.01.03 **Energy Attenuator - Relocation, Narrow**
Energy Attenuator - Relocation, Wide
Energy Attenuator - Relocation, Extra Wide
Energy Attenuator - Relocation, Super Wide
Energy Attenuator - Relocation, Reduced Exposure
Energy Attenuator - Relocation, Dual Duty

For measurement purposes, a count shall be made of the number of complete energy attenuator systems relocated. Systems that are temporarily surplus and are required for future stages shall be paid for as one relocation for the combined moves into and out of storage, including any off-site storage required due to on-site restrictions.

723.09.02 **Plan Quantity Measurement**

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

723.10 **BASIS OF PAYMENT**

723.10.01 **Energy Attenuator - Permanent, Narrow - Item**
Energy Attenuator - Permanent, Wide - Item
Energy Attenuator - Permanent, Extra Wide - Item
Energy Attenuator - Permanent, Super Wide - Item
Energy Attenuator - Permanent, High Exposure - Item
Energy Attenuator - Permanent, Single-Sided - Item
Energy Attenuator - Temporary, Narrow - Item
Energy Attenuator - Temporary, Wide - Item
Energy Attenuator - Temporary, Extra Wide - Item
Energy Attenuator - Temporary, Super Wide - Item
Energy Attenuator - Temporary, Reduced Exposure - Item
Energy Attenuator - Temporary, Dual Duty - Item
Energy Attenuator - Relocation, Narrow - Item
Energy Attenuator - Relocation, Wide - Item
Energy Attenuator - Relocation, Extra Wide - Item
Energy Attenuator - Relocation, Super Wide - Item
Energy Attenuator - Relocation, Reduced Exposure - Item
Energy Attenuator - Relocation, Dual Duty - Item

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

When the Contract contains separate items for the work required by this specification, payment shall be at the Contract price and according to the specification for such work.

Costs associated with any required removals and replacement or repairs of defective work and materials shall be the Contractor's responsibility at no additional cost to the Owner.

TABLE 1
Energy Attenuator, Permanent (EAP)

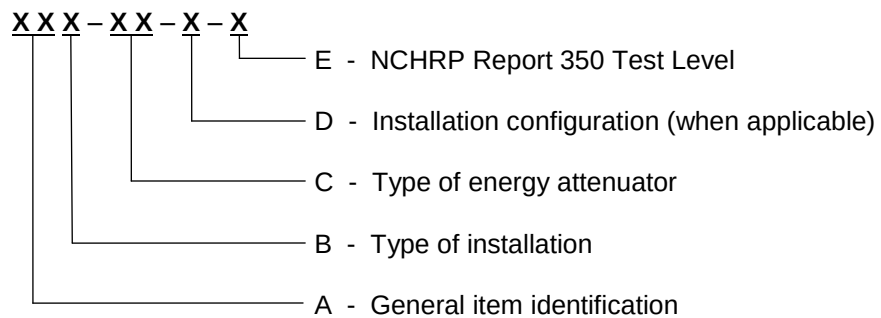
Energy Attenuator	NCHRP Report 350 Test Level		Permanent Installation					
	TL-2	TL-3	Narrow (NA)	Wide (WI)	Extra Wide (EW)	Super Wide (SW)	High Exposure (HE)	Single- Sided (SS)
TAU-II System	Yes	Yes	Yes	No	No	No	No	No
TAU-II Wide System	Yes	Yes	No	Yes	No	No	No	No
TAU-II Extra Wide System	Yes	Yes	No	No	Yes	No	No	No
Quadguard System	Yes	Yes	Yes	No	No	No	No	No
Quadguard Wide System	Yes	Yes	No	Yes	No	No	No	No
Quadguard Extra Wide System	Yes	Yes	No	No	Yes	No	No	No
Quadguard Super Wide System	No	Yes	No	No	No	Yes	No	No
QuadTrend	No	Yes	No	No	No	No	No	Yes
BB-BEAT	No	Yes	No	No	No	No	No	Yes
Smart System	Yes	Yes	Yes	No	No	No	Yes	No

TABLE 2
Energy Attenuator, Temporary (EAT)

Energy Attenuator	NCHRP Report 350 Test Level		Temporary Installation					
	TL-2	TL-3	Reduced Exposure (RE)	Narrow (NA)	Wide (WI)	Extra Wide (EW)	Super Wide (SW)	Dual Duty (DD)
TAU-II System	Yes	Yes	Yes	Yes	No	No	No	No
TAU-II Wide System	Yes	Yes	No	No	Yes	No	No	No
TAU-II Extra Wide System	Yes	Yes	No	No	No	Yes	No	No
ABSORB 350 System	Yes	Yes	Yes	No	No	No	No	No
Quadguard System	Yes	Yes	Yes	Yes	No	No	No	No
Quadguard Wide System	Yes	Yes	No	No	Yes	No	No	No
Quadguard Extra Wide System	Yes	Yes	No	No	No	Yes	No	No
Quadguard Super Wide System	No	Yes	No	No	No	No	Yes	No
ACZ 350 System	Yes	Yes	Yes	No	No	No	No	No
Smart System	Yes	Yes	Yes	Yes	No	No	No	Yes
TRACC System	Yes	Yes	Yes	Yes	No	No	No	No

TABLE 3
Contract Drawing Notation

A	EA - Energy Attenuator
B	P - Permanent T - Temporary R - Relocation
C	NA - Narrow WI - Wide EW - Extra Wide SW - Super Wide HE - High Exposure SS - Single-Sided RE - Reduced Exposure DD - Dual Duty
D	U - Unidirectional B - Bidirectional N - Not applicable
E	2 - NCHRP Report 350 TL-2 3 - NCHRP Report 350 TL-3



Appendix 723-A, November 2015
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

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

Designer Action/Considerations

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.