



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for use of Ontario Provincial Standards; therefore, manual holders are cautioned about immediately discarding superseded and cancelled standards.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

Remove the entire index and replace with the revised index.

Standard Specifications Volume 7

Superseded/Cancelled (Remove)		Revised/New (Insert)		Remarks
OPSS.MUNI	Dated	OPSS.MUNI	Dated	
209	November 2014	209	November 2015	“CONSTRUCTION SPECIFICATION FOR EMBANKMENTS OVER SWAMPS AND COMPRESSIBLE SOILS” 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.
--	--	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.MUNI 209

CONSTRUCTION SPECIFICATION FOR EMBANKMENTS OVER SWAMPS AND COMPRESSIBLE SOILS

- Section 209.03, Definitions, definitions for Hydraulic Backhoe Reach, added.
- Subsection 209.07.02, Clearing and Close Cut Clearing, 1st paragraph modified with addition of 2nd sentence taken from Clause 209.07.04.03, 1st paragraph.
- Subsection 209.07.03, Excavation Method, 2nd and 3rd paragraph rewritten.
- Clause 209.07.04.03, 1st paragraph modified with removal of second sentence to Subsection 209.07.02, Clearing and Close Cut Clearing. Existing 4th and 5th paragraph combined and rewritten into 4th paragraph.
- Clause 209.07.05.01, 1st paragraph modified with “the original surface of the swamp” vs “original ground”.
- Clause 209.09.01.02, the existing 1st paragraph 1st sentence rewritten and addition of 2nd sentence regarding hauling.
- Subsection 209.10.02, Rental of Swamp Excavation Equipment, Dragline – Item Rental of Swamp Excavation Equipment, Hydraulic Backhoe –Item, 2nd and 4th paragraph added.
- Subsection 209.10.05, Management of Excavation by Equipment Rental, 1st paragraph modified with addition of “except trucking”.
- Appendix 209-A, Designer Action/Considerations, 5th, 6th and 13th paragraph added.

SUMMARY OF REVISIONS TO OPSS.MUNI 314

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

The municipal version of OPSS 314 has been published in OPS Volume 7 as OPSS.MUNI 314, mainly for municipal use.

Although OPSS.MUNI 314 is based on OPSS 314, no revisions have been made to the technical information.

SUMMARY OF REVISIONS TO OPSS.MUNI 331

CONSTRUCTION SPECIFICATION FOR FULL DEPTH RECLAMATION WITH EXPANDED ASPHALT STABILIZATION

The municipal version of OPSS 331 has been published in OPS Volume 7 as OPSS.MUNI 331, mainly for municipal use.

Although OPSS.MUNI 331 is based on OPSS 331, no revisions have been made to the technical information.

SUMMARY OF REVISIONS TO OPSS.MUNI 333

CONSTRUCTION SPECIFICATION FOR COLD IN-PLACE RECYCLING

The municipal version of OPSS 333 has been published in OPS Volume 7 as OPSS.MUNI 333, mainly for municipal use.

Although OPSS.MUNI 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:

- Entire specification converted to Municipal-oriented format.
- Section 333.02, References, LS-602 and SP-027 added to the Ontario Ministry of Transportation Publications.
- Section 333.03, Definitions, Segregation re-defined and a new definition for Target Density added.
- Section 333.05.03, Emulsified Asphalt, Updated.
- Section 333.05.04, Reclaimed Asphalt Pavement, Updated.
- Section 333.06.03, Compaction Equipment, Updated.
- Section 333.06.04, Drying Unit, Updated.
- Section 333.07.02, Operational Constraints, Updated.
- Section 333.07.03, Cold In-Place Recycling Trial Section, Updated.
- Section 333.07.08, Drying, Updated.
- Section 333.07.09.02, Cold In-Place Recycling Material, Re-written.
- Section 333.07.09.03, Emulsified Asphalt, New section added.
- Table 1, Unacceptable CIR Mix and Required Repair, SP-024 replaced with SP-027.
- Designer Actions/Commentary, Updated.

SUMMARY OF REVISIONS TO OPSS.MUNI 335

CONSTRUCTION SPECIFICATION FOR COLD IN-PLACE RECYCLING WITH EXPANDED ASPHALT

The municipal version of OPSS 335 has been published in OPS Volume 7 as OPSS.MUNI 335, mainly for municipal use.

Although OPSS.MUNI 335 is based on OPSS 335, no revisions have been made to the technical information.

SUMMARY OF REVISIONS TO OPSS.MUNI 401

CONSTRUCTION SPECIFICATION FOR TRENCHING, BACKFILLING, AND COMPACTING

The municipal version of OPSS 401 has been published in OPS Volume 7 as OPSS.MUNI 401, mainly for municipal use.

Although OPSS.MUNI 401 is based on OPSS 401, no revisions have been made to the technical information.

SUMMARY OF REVISIONS TO OPSS.MUNI 410

CONSTRUCTION SPECIFICATION FOR PIPE SEWER INSTALLATION IN OPEN CUT

The municipal version of OPSS 410 has been published in OPS Volume 7 as OPSS.MUNI 410, mainly for municipal use.

Although OPSS.MUNI 410 is based on OPSS 410, no revisions have been made to the technical information.

SUMMARY OF REVISIONS TO OPSS.MUNI 421

CONSTRUCTION SPECIFICATION FOR PIPE CULVERT INSTALLATION IN OPEN CUT

The municipal version of OPSS 421 has been published in OPS Volume 7 as OPSS.MUNI 421, mainly for municipal use.

Although OPSS.MUNI 421 is based on OPSS 421, no revisions have been made to the technical information.

SUMMARY OF REVISIONS TO OPSS.MUNI 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.MUNI 723

CONSTRUCTION SPECIFICATION FOR ENERGY ATTENUATORS

- Section 723.02, References; OPSS 1442 deleted, OPSS 1440 added, and 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.
- Subsection 723.05.04, Steel Reinforcement, title revised and reference to OPSS 1442 revised to OPSS 1440.
- Clause 723.07.03.04, 2nd paragraph, winter shutdown revised to seasonal shutdown.
- Clause 723.09.01.01; Energy Attenuator – Permanent, Super Wide and Quadguard Super Wide System – Permanent added.
- Clause 723.09.01.02; Energy Attenuator – Temporary, Super Wide and Quadguard Super Wide System – Temporary added.
- Clause 723.09.01.03; Energy Attenuator – Relocation, Super Wide and Quadguard Super Wide System – Relocation added.
- Subsection 723.10.01; Energy Attenuator – Permanent, Super Wide – Item; Quadguard Super Wide System – Permanent – Item; Energy Attenuator – Temporary, Super Wide – Item; Quadguard Super Wide System – Temporary – Item; Energy Attenuator – Relocation, Super Wide; and Quadguard Super Wide System – Relocation – Item; added.
- Table 1, 2 and 3; Quadguard Super Wide System added.
- Appendix 723-A, Related Ontario Provincial Standard Drawings; OPSD 923.006, OPSD 923.192, OPSD 923.193, OPSD 923.194, and OPSD 923.195 added.

MANUAL REVISION RECORD

Municipal-Oriented

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

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

REVISION NUMBER	REVISION DATE	ENTERED BY	REVISION NUMBER	DATE	ENTERED BY
1	APRIL 2008	Included in new manuals	27		
2	NOV 2008	Included in new manuals	28		
3	APR 2010	Included in new manuals	29		
4	NOV 2010	Included in new manuals	30		
5	APR 2012	Included in new manuals	31		
6	NOV 2012	Included in new manuals	32		
7	NOV 2013	Included in new manuals	33		
8	NOV 2014	Included in new manuals	34		
9	APR 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.MUNI	TITLE
OPS GENERAL CONDITIONS OF CONTRACT		
NOV 2006	100	OPS General Conditions of Contract
DIVISION 1 - GENERAL SPECIFICATIONS		
NOV 2012	106	Notice to Users of OPSS 106 (Electrical Work)
NOV 2014	120	The Use of Explosives
NOV 2012	182	Environmental Protection for Construction in Waterbodies and on Waterbody Banks
DIVISION 2 - GENERAL GRADING		
NOV 2013	206	Grading
NOV 2015	209	Embankments Over Swamps and Compressible Soils
NOV 2013	212	Borrow
NOV 2014	220	Wick Drain Installation
DIVISION 3 - PAVEMENT (FLEXIBLE AND RIGID)		
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
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



**ONTARIO
PROVINCIAL
STANDARD
SPECIFICATION**

VOLUME 7 INDEX

**MUNICIPAL-ORIENTED
OPS GENERAL CONDITIONS OF CONTRACT AND
GENERAL & CONSTRUCTION SPECIFICATIONS**

DATE	SPEC. NO. OPSS.MUNI	TITLE
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 System
NOV 2014	771	Standard Highway Fence
DIVISION 8 - ENVIRONMENTAL AND LANDSCAPE		
NOV 2014	804	Seed and Cover
DIVISION 9 - STRUCTURAL		
NOV 2012	904	Concrete Structures
NOV 2014	905	Steel Reinforcement for Concrete
NOV 2014	908	Metal Traffic Barriers and Metal Railings for Structures
NOV 2005	910	Stressing Systems for Post-Tensioning
NOV 2014	911	Coating Structural Steel Systems
NOV 2014	914	Waterproofing Bridge Decks with Hot Applied Asphalt Membrane
NOV 2014	915	Sign Support Structures
NOV 2012	920	Deck Joint Assemblies, Preformed Seals, Joint Fillers, Joint Seals, Joint Sealing Compounds, and Waterstops - Structures



**ONTARIO
PROVINCIAL
STANDARD
SPECIFICATION**

VOLUME 7 INDEX

**MUNICIPAL-ORIENTED
OPS GENERAL CONDITIONS OF CONTRACT AND
GENERAL & CONSTRUCTION SPECIFICATIONS**

DATE	SPEC. NO. OPSS.MUNI	TITLE
APR 2012	928	Structure Rehabilitation - Concrete Removal
NOV 2014	930	Structure Rehabilitation - Concrete Patches and Overlays



**ONTARIO
PROVINCIAL
STANDARD
SPECIFICATION**

VOLUME 7 INDEX

**MUNICIPAL-ORIENTED
OPS GENERAL CONDITIONS OF CONTRACT AND
GENERAL & CONSTRUCTION SPECIFICATIONS**



CONSTRUCTION SPECIFICATION FOR EMBANKMENTS OVER SWAMPS AND COMPRESSIBLE SOILS

TABLE OF CONTENTS

209.01	SCOPE
209.02	REFERENCES
209.03	DEFINITIONS
209.04	DESIGN AND SUBMISSION REQUIREMENTS - Not Used
209.05	MATERIALS
209.06	EQUIPMENT
209.07	CONSTRUCTION
209.08	QUALITY ASSURANCE - Not Used
209.09	MEASUREMENT FOR PAYMENT
209.10	BASIS OF PAYMENT

APPENDICES

209-A	Commentary
--------------	-------------------

209.01 SCOPE

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

209.01.01 Specification Significance and Use

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

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

209.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

209.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Construction

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

Ontario Provincial Standard Specifications, Material

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

209.03 DEFINITIONS

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

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

Earth means as defined in OPSS 206.

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

Rock means as defined in OPSS 206.

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

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

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

209.05 MATERIALS

209.05.01 Embankment Material

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

209.05.01.01 Earth Borrow or Rock Borrow

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

209.05.01.02 Select Subgrade Material

Select subgrade material shall be according to OPSS 1010.

209.05.02 Geotextile

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

209.06 EQUIPMENT

209.06.01 Rented Swamp Excavator

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

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

209.06.02 Spreading, Levelling, and Compacting Equipment

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

209.07 CONSTRUCTION

209.07.01 General

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

- a) Excavation Method

b) Floatation Method

c) Displacement Method

209.07.02 Clearing and Close Cut Clearing

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

209.07.03 Excavation Method

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

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

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

209.07.03.01 Embankment Construction and Backfill

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

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

209.07.04 Floatation Method

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

209.07.04.01 Swamp Waves

Swamp waves shall not be excavated or otherwise disturbed.

209.07.04.02 Embankment Construction

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

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

209.07.04.03 Geotextile

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

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

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

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

209.07.05 Displacement Method

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

209.07.05.01 Embankment Construction

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

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

209.07.06 Management of Excess Material

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

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

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

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

209.09 MEASUREMENT FOR PAYMENT

209.09.01 Actual Measurement

209.09.01.01 Excavation

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

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

209.09.01.02 Rental of Swamp Excavation Equipment

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

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

209.09.01.03 Select Subgrade Material

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

209.09.01.03.01 Cubic Metre Measurement

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

a) End Area Method

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

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

b) Truck Box Method

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

Each truck shall be uniquely and readily identifiable.

209.09.01.04 Geotextile

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

209.09.02 Plan Quantity Measurement

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

209.10 BASIS OF PAYMENT

209.10.01 Excavation

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

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

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

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

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

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

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

209.10.03 Floatation and Displacement Method

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

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

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

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

209.10.05 Management of Swamp Material Excavated by Equipment Rental

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

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

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

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

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

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

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

- Type of rental swamp excavation equipment. (209.06.01)

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

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

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

Related Ontario Provincial Standards Drawings

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



**ONTARIO
PROVINCIAL
STANDARD
SPECIFICATION**

**METRIC
OPSS.MUNI 314
NOVEMBER 2015**
(Formerly OPSS 314, November 2013)

**CONSTRUCTION SPECIFICATION FOR
UNTREATED GRANULAR SUBBASE, BASE,
SURFACE, SHOULDER, 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 - Not Used
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 untreated granular subbase, base, roadway surface and shoulder, edge ramping for bituminous pavements, and stockpiling at specified sites.

314.01.01 Specification Significance and Use

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

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

314.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

314.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 350	Concrete Pavement and Concrete Base
OPSS 501	Compacting

Ontario Provincial Standard Specifications, Material

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

314.03 DEFINITIONS

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

Construction Grading Report means a tabular report provided by the Contract Administrator that identifies stations, offsets, and elevations for granular surfaces consistent with the design cross-section.

Quality Assurance (QA) means a system or series of activities carried out by the Owner to ensure that materials received from the Contractor meet the specified requirements.

Quality Control (QC) means a system or series of activities carried out by the Contractor to ensure that materials supplied to the Owner meet the specified requirements.

314.05 MATERIALS

314.05.01 Aggregates

Granular material and select subgrade material shall be according to OPSS 1010.

314.07 CONSTRUCTION

314.07.01 Granular Subbase, Base, and Surface

Material shall be kept free from clay and other types of deleterious material. The Contractor's operations shall not disturb underlying work.

Material shall be placed without segregation in uniform layers such that the thickness of the compacted layer is not greater than 150 mm, except as provided under the Modified Layer Compaction Method clause.

Each layer shall be bladed to a smooth surface according to the required cross-section and maintained until placement of a subsequent layer, when applicable.

Prior to closing down operations for the completion of each day's work, the subbase material shall be bladed and compacted and, if necessary, covered with sufficient base material to carry traffic.

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

314.07.02 Winter Grading of Granular

All ice and snow shall be removed from all portions of the Work Area. Frozen material shall not be incorporated into the Work. Material shall not be placed over frozen ground, except, at the Contractor's option, a single lift may be placed over frozen ground; in which case, final grading and compaction shall be done after the underlying material has thawed.

314.07.03 Edge Ramping of Bituminous Pavement

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

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

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

314.07.04 Shoulders

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

Before commencing shoulder construction, all debris and deleterious material shall be removed from the shoulder area.

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

a) Bituminous Pavements

Placement of granular material for shouldering operations shall not commence along any section of pavement until 24 hours have elapsed from the time of completion of the final bituminous pavement course in that section. The shouldering operations shall be completed within 24 hours on sections of pavement that are open to traffic. When the pavement is not open to traffic, the shouldering shall be completed before traffic is permitted.

b) Concrete Pavement and Concrete Base

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

All shoulder construction material shall be conveyed from the transport vehicle onto the shoulder area. End dumping of shoulder construction material directly on to the adjacent pavement surface or directly on to the shoulder shall not be permitted. The material shall be uniformly distributed within the specified shoulder limits without segregation. Grading and shaping operations shall confine all material to within the specified shoulder limits without overspill. Any shoulder construction material deposited, dragged, or inadvertently placed on the pavement surface shall be removed immediately and the pavement surface shall be thoroughly cleaned with the use of a power broom or other suitable means.

Operation of equipment shall not cause any damage to the pavement.

314.07.05 Compaction

314.07.05.01 General

Each layer of material shall be compacted as specified before the next layer is placed.

314.07.05.02 Compaction Requirements

The compaction requirements shall be according to OPSS 501.

314.07.05.03 Modified Layer Compaction Method

At the option of the Contractor, granular material may be placed in layers thicker than permitted under the Granular Subbase, Base, and Surface subsection, subject to the following provisions:

- a) All material shall be placed in uniform layers such that each layer shall have a depth of not more than 300 mm after compaction.
- b) Before placing each material in thicker layers, the Contractor shall prove, in a two lane trial area, the ability of the proposed compaction method to achieve the specified density. The location and extent of the trial area shall be approved by the Contract Administrator. At least 48 hours notice shall be given to the Contract Administrator before any work commences on the trial area. Full details of the proposed placing and compacting system or systems, including the rate of placing, depth of layer, number and type of compaction units, and number of passes shall be given to the Contract Administrator. The areas

designated to evaluate each system shall be of sufficient length to be representative of the proposed method and shall normally be approximately 150 m in length.

- c) When the Contract Administrator, on the basis of test results, approves a system of placing and compacting, the system shall be used for the remainder of the work to which it is applicable, except that:
 - i. Should the Contractor find it necessary at any time to change the system or any part of it, including the source of material or the rate of placing the material, the Contractor shall first obtain approval from the Contract Administrator, who may require a further trial area.
 - ii. If at any time tests show that a previously approved system is no longer producing the specified compaction, the Contractor shall make whatever changes are necessary to satisfy the requirements of this specification.

314.07.06 Tolerances

314.07.06.01 General

The surface of the uppermost layer of granular material shall be bladed, shaped, and compacted to produce the specified grade and cross-section.

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

314.07.06.02 Granular Courses

The finished granular courses shall not deviate more than 30 mm from the specified grade and cross-section and the surface shall not deviate more than 15 mm at any place as measured in any direction with a 3 m straight edge.

314.07.06.03 Bituminous Courses, Sidewalk, Curb, and Gutter

The finished granular surface shall not deviate more than 30 mm from the specified grade and cross-section, except when the finished bituminous grade is controlled by fixed components such as existing pavements and curbs, in which case the finished granular surface shall not deviate more than 10 mm from the specified grade. Granular surfaces shall not deviate more than 10 mm at any place as measured in any direction with a 3 m straight edge.

314.07.06.04 Concrete Courses, Sidewalk, Curb, and Gutter

The finished granular surface shall not deviate more than 10 mm from the specified grade and cross-section and the surface shall not deviate more than 10 mm at any place as measured in any direction with a 3 m straight edge.

314.07.07 Stockpiling of Granular Material

Stockpiles of granular material shall be constructed according to OPSS 1001 at sites specified in the Contract Documents.

314.07.08 Quality Control

The Contractor shall carry out grade checks on the finished granular surfaces and carry out all QC grade checks required to ensure that the finished granular courses are built to within the specified tolerances for grade and cross-section. QC of granular grading shall be based on surface tolerances of the finished granular

courses, as provided in the Tolerances subsection. The grade shall be certified at the stations and offsets shown in the Construction Grading Report.

314.07.09 Submission of Grade Checks

All grade checks relating to horizontal and vertical grading tolerances, including all non-compliances, shall be submitted to the Contract Administrator within 2 Business Days following completion of the grade. The Contractor shall sign and certify the construction grading report as correct.

When grading templates are available, the Contractor shall sign and certify the template as correct. If no template is available, the Contractor shall complete, sign, and submit form OPSF 314-1 to the Contract Administrator.

314.07.10 Management of Excess Material

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

314.08 QUALITY ASSURANCE

314.08.01 General

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

314.08.02 Finished Grades Outside Specification

When the finished granular grade or cross-section or both do not meet the acceptance criteria, the granular course shall be brought to grade or cross-section or both within the specified tolerances.

314.08.03 Acceptance

Provided that the Contract Administrator's grade checks are according to those determined by the Contractor, no action shall be taken. If discrepancies between QA and QC grade checks occur, additional QA grade checks may be conducted by the Contract Administrator. If the Contract Administrator chooses not to take QA grade checks, the work shall be accepted on the basis of QC grade checks.

If the finished grade or cross-section or both are not according to the specification, the Contractor shall be required to bring the granular surface to grade or cross-section or both within the specified tolerances and recertify the grade.

314.09 MEASUREMENT FOR PAYMENT

314.09.01 Actual Measurement

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

314.09.01.01.01 Tonne

When payment is by the tonne:

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

314.09.01.01.02 Cubic Metre

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

a) End Area Method

i. At Source

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

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

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

ii. In Place

When the measurement for payment of material in their original location is not possible, the measurement for payment shall be made of material measured in place with no allowance for shrinkage and computed in cubic metres by the method of average end areas.

b) Truck Box Method

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

Each truck shall be uniquely and readily identifiable.

314.09.01.01.03 Square Metre

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

314.09.02 Plan Quantity Measurement

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

314.10 BASIS OF PAYMENT

- 314.10.01**
- Granular A - Item**
 - Granular A, Stockpiled - Item**
 - Granular A, from Stockpile - Item**

 - Granular B Type I - Item**
 - Granular B Type I, Stockpiled - Item**
 - Granular B Type I, from Stockpile - Item**

 - Granular B Type II - Item**
 - Granular B Type II, Stockpiled - Item**
 - Granular B Type II, from Stockpile - Item**

 - Granular B Type III - Item**
 - Granular B Type III, Stockpiled - Item**
 - Granular B Type III, from Stockpile - Item**

 - Granular M - Item**
 - Granular M, Stockpiled - Item**
 - Granular M, from Stockpile - Item**

 - Granular O - Item**
 - Granular O, Stockpiled - Item**
 - Granular O, from Stockpile - Item**

 - Granular S - Item**
 - Select Subgrade Material, Compacted - Item**

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

The cost of any additional QA grade checks on the recertified area shall be the responsibility of the Contractor. All grading carried out by the Contractor as a result of QA grade checks to ensure tolerances shall be carried out at no additional charge to the Owner.

Compensation for the cleanup of the stockpile site on completion of the operation, when required, shall be included as part of the granular item cost.

314.10.02 From Stockpile

Compensation for clearing, grubbing, stripping, cleanup of the stockpile site, and for supplying and placing a pad upon which the materials are to be stockpiled shall be included as part of the granular item cost.

CERTIFICATION OF GRADE ELEVATION / CROSSFALL

CONTRACT _____

LOCATION _____

COMPONENTS _____

LOCATION _____

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

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

OPSF 314-1

Appendix 314-A, November 2013
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

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

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Location, line, grade, and cross-section for granular material. (314.07.04)
- Sites for stockpiles of granular material. (314.07.07)

On projects requiring grading, the designer should provide a Construction Grading Report.

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

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR 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; adding and blending corrective aggregate or active filler or both, if required; adding and mixing expanded asphalt; and shaping and compacting the expanded asphalt mix.

331.01.01 Specification Significance and Use

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

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

331.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

331.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 301	Restoring Unpaved Roadway Surfaces
OPSS 310	Hot Mix Asphalt
OPSS 501	Compacting

Ontario Provincial Standard Specifications, Material

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

Ontario Ministry of Transportation Publications

MTO Laboratory Testing Manual:

LS-200	Penetration of Bituminous Materials
LS-282	Quantitative Extraction of Asphalt Cement and Analysis of Extracted Aggregate from Bituminous Paving Mixtures
LS-292	Quantitative Determination of Asphalt Cement Content by Ignition and Analysis of Remaining Aggregate from Bituminous Paving Mixtures
LS-297	Determination of Indirect Tensile Strength of Expanded Asphalt Mixes
LS-625	Sampling of Granular Materials

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

Wirtgen GmbH Publication

Wirtgen Cold Recycling Technology manual, 3rd edition, 2010

331.03 DEFINITIONS

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

Active Filler means substances added to the reclaimed materials that chemically alter the mix properties.

AMRL means as defined in OPSS 310.

CCIL means as defined in OPSS 310.

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

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

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

Performance Graded Asphalt Cement (PGAC) means as defined in OPSS 310.

Quality Assurance (QA) means as defined in OPSS 310.

Quality Control (QC) means as defined in OPSS 310.

Reclaimed Asphalt Pavement (RAP) means as defined in OPSS 310.

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

331.04 DESIGN AND SUBMISSION REQUIREMENTS

331.04.01 Design Requirements

For mix design purposes, prior to commencing the work the Contractor shall obtain samples representative of the material that is produced during in-place full-depth reclamation. These samples shall be used to establish the design rate of expanded asphalt as a per cent by mass of the unstabilized material. The design rate of the expanded asphalt shall be a minimum of 2.8%. The dry tensile strength shall be a minimum of 225 kPa and the wet tensile strength shall be a minimum of 100 kPa. The tensile strength ratio shall be a minimum of 50%.

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

Each mix design shall include the following

- a) Information on the grade, manufacturer, and supplier of the PGAC.

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

331.04.02 Submission Requirements

The mix design shall be submitted by the Contractor to the Contract Administrator a minimum of 7 Days prior to the start of the reclamation and stabilization. When more than one mix design is required, the area for which each mix design is to be used shall be clearly identified.

A new mix design shall be submitted when the expanded asphalt design rate is adjusted by 0.3% or greater. Separate or new mix designs shall be submitted if the composition or layer thicknesses or both of the existing pavement changes significantly.

331.05 MATERIALS

331.05.01 Active Filler

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

When used as active filler, Portland cement shall be according to OPSS 1301. No more than one per cent by mass of Portland cement shall be added to the mix.

331.05.02 Corrective Aggregate

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

331.05.03 Performance Graded Asphalt Cement

The Contractor shall select a PGAC with suitable expansion characteristics. PGAC shall be according to OPSS 1101, excluding the PGAC zone requirements.

331.05.04 Reclaimed Asphalt Pavement

RAP material shall be 100% passing the 37.5 mm sieve and 95 to 100% passing the 26.5 mm sieve after processing.

331.05.05 Water

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

331.06 EQUIPMENT

331.06.01 Full-Depth Reclamation and Stabilization Equipment

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

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

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

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

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

Alternative equipment may be considered subject to approval by the Contract Administrator and demonstration of meeting the requirements of the Expanded Asphalt Trial Section subsection.

331.06.02 Placing Equipment

Placing of the expanded asphalt mix shall be carried out by means of a self-propelled mechanical paver capable of spreading the mix evenly in front of the screed in one continuous pass to the specified cross-fall and grade. The paver shall be equipped with distributing augers for the full width to be paved. The paver shall have a vibratory screed capable of vibrating the full width of mix placed.

331.06.03 Pilot Vehicle

The pilot vehicle shall be according to the requirements of the OTM, Book 7.

331.07 CONSTRUCTION

331.07.01 Operational Constraints

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

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

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

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

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

- a) The EAM has been allowed to cure for a minimum of 2 Days.
- b) The Contractor has demonstrated that the EAM meets all the requirements of this specification.
- c) All defective areas in the EAM have been repaired to the satisfaction of the Contract Administrator.

331.07.02 In-Place Full-Depth Reclamation

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

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

331.07.03 Expanded Asphalt Trial Section

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

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

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

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

The Contractor shall be responsible for the repair, removal, or replacement of an unacceptable trial section.

331.07.04 Expanded Asphalt Stabilization

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

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

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

331.07.05 Grading and Compacting the Expanded Asphalt Mix

The material shall be compacted to a minimum 97% of the target density, as determined in OPSS 501 for granular materials.

The compacted surface of the EAM shall be according to the surface tolerances specified in OPSS 301. Regrading of the EAM to correct crossfall deficiencies shall be minimized.

The compacted surface of the EAM shall be uniform in texture and free of segregation, longitudinal streaks, flushing, fat spots, oil spills, roller marks, and other surface defects.

331.07.06 Sampling

The Contractor shall be responsible for all sampling.

331.07.06.01 Corrective Aggregate

The Contract Administrator may request samples of the corrective aggregate to demonstrate conformance to the requirements of this specification. When requested, two 25 kg samples shall be taken in the presence of the Contract Administrator.

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

Samples of corrective aggregate shall be obtained, properly labelled and identified, and delivered within 48 hours of sampling to the designated QA testing laboratory as specified in the Contract Documents.

331.07.06.02 Active Filler

The Contract Administrator may request samples of active filler to demonstrate conformance to the requirements of this specification.

331.07.06.03 Expanded Asphalt Mix

Samples of unstabilized material and EAM shall be taken at a minimum frequency of one set of samples per 5,000 m². To obtain a set of samples, the Contractor shall take one 15 kg sample of unstabilized material immediately following in-place full depth reclamation and from the same approximate location a second 15 kg sample of EAM, immediately following stabilization. The maximum sampling depth shall be 100 mm. The second sample may be obtained after placement and prior to compaction.

The samples shall be packaged in a non-absorptive material to protect sample integrity, sealed in waterproof containers, appropriately labelled, and delivered by the Contractor in good condition within 48 hours of sampling to the designated QA testing laboratory specified in the Contract Documents.

331.07.07 Traffic Convoy

When specified in the Contract Documents, the Contractor shall convoy traffic according to the OTM, Book 7.

The pilot vehicle shall guide one-way traffic through or around construction. The maximum speed of the convoy shall be 30 km/h. Convoing shall be maintained until such time as the expanded asphalt stabilized mat is able to carry traffic without damage.

331.07.08 Management of Excess Material

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

331.08 QUALITY ASSURANCE

331.08.01 General

Acceptance shall be based on QA testing. QA testing shall be carried out by a laboratory currently certified by CCIL with Type A or Type B certification or AMRL accredited or equivalent laboratory.

Acceptance criteria shall be based on the QA test results for each 5,000 m² placed.

The Contract Administrator shall reject all unacceptable material and all visually defective material, mix, or work. Defective material, mixture, and work shall not be incorporated into the finished work.

331.08.02 Acceptance of Corrective Aggregate

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

331.08.03 Acceptance of the Expanded Asphalt Mix

331.08.03.01 Asphalt Cement Content

The sample of unstabilized material taken immediately following in-place full depth reclamation and the sample of EAM taken immediately after stabilization shall be tested for total asphalt cement content in accordance with LS-282 or LS-292. The total asphalt cement content of the EAM includes existing aged asphalt cement and new asphalt cement. The per cent by mass of new asphalt cement added to the unstabilized material shall be determined from the two samples at each location by subtracting the total asphalt cement content of the unstabilized material from the total asphalt cement content of the EAM.

The average new asphalt cement content of each 5,000 m² placed shall not be less than 0.4% or more than 0.6% of the established mix design.

331.08.03.02 Tensile Strength

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

Dry tensile strength requirements for the sample are met when the dry tensile strength of the sample is equal to or greater than the minimum requirement of 225 kPa.

Wet tensile strength requirements for the sample are met when wet tensile strength of the sample is equal to or greater than the minimum requirement of 100 kPa.

The tensile strength ratio for the sample shall not be less than 50%.

331.08.04 Acceptance of Thickness

Thickness of the EAM shall be measured by the Contract Administrator. Measurements shall be taken by excavating along the edge of the stabilized pass with a shovel and measuring the depth of stabilization from the bottom of the EAM to the surface of the adjacent unstabilized material. Thickness requirements for each 5,000 m² are met when the following are satisfied:

- a) At least 90% of all thickness measurements for each 5,000 m² are equal to or greater than the specified thickness minus 20 mm.
- b) No individual thickness measurement for each 5,000 m² is less than the specified thickness minus 30 mm.

331.08.05 Acceptance of Compaction

Compaction measurements shall be taken by the Contract Administrator according to OPSS 501 for granular materials. Compaction requirements of the EAM placed are met when the following are satisfied:

- a) The average of all compaction measurements for each 5,000 m² is greater than or equal to 97% of the target density.
- b) No individual compaction measurement for each 5,000 m² is less than 95% of the target density.

331.08.06 Repairing and Re-Decisioning

With the exception of repairs for surface tolerance, the minimum width of repair shall be the full width of the reclaimer-stabilizer equipment, the minimum length shall be sufficient for the repair to be carried out, and all repairs shall be made using the same equipment as was used during initial production and placement.

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

Unacceptable EAM, including any area damaged or contaminated by traffic or by natural or added water shall be reprocessed and, if required, additional expanded asphalt added. Alternatively, the Contractor shall remove and replace damaged or otherwise unacceptable EAM with the same hot mix type to be used in the overlying hot mix lift to a minimum depth of 50 mm according to OPSS 310.

Mixes that cannot be compacted to the specified density shall be removed to a minimum depth of 50 mm and replaced by an appropriate HMA approved by the Contract Administrator. When it is determined that the compaction cannot be achieved due to poor subgrade conditions, the Owner shall be responsible for the cost of repairs.

331.09 MEASUREMENT FOR PAYMENT

331.09.01 Actual Measurement

331.09.01.01 Full-Depth Reclamation with Expanded Asphalt Stabilization

Full-depth reclamation with expanded asphalt stabilization shall be measured for payment by horizontal area in square metres.

331.09.02 Plan Quantity Measurement

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

331.10 BASIS OF PAYMENT

331.10.01 Full-Depth Reclamation with Expanded Asphalt Stabilization - Item

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

The addition of corrective aggregate or active filler to the mix shall be at no extra cost to the Owner.

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

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

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

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

**Appendix 331-A, November 2011
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS**

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

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- The depths and widths for reclaiming existing asphalt pavement and underlying granular base. (331.07.02)
- The depth and limits of expanded asphalt stabilization. (331.07.04)

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

- Traffic convoy requirements. (331.07.07)

Expanded asphalt mix (EAM) is a reclaimed asphalt pavement and granular base stabilized in-place by the addition of expanded asphalt and, if required, corrective aggregate and active filler.

EAM is a bound material and does not exhibit the same drainage characteristics as granular base material.

Expanded or "foamed" asphalt is created by injecting a carefully metered amount of cold water into hot asphalt cement in the mixing chamber of a pulverizer-stabilizer. The asphalt expands, reducing the viscosity of the asphalt cement and allowing easier dispersion throughout the mix.

The expanded asphalt bonds most effectively with finer aggregate particles forming a mortar to bond the coarser aggregate particles together. The stabilization process requires fines in order to be effective.

It is recommended that adequate pre-engineering be carried out on the project and that existing pavement thicknesses and composition be established. Additional investigation should be carried out when pavement composition changes, such as patched areas. Pre-engineering data should be included in the contract documentation.

The selected performance graded asphalt cement (PGAC) must have suitable expansion characteristics. Polymer modified PGAC may adversely affect the foaming process. There is no requirement for a PGAC to be selected based on climatic zones, as the stabilized layer is expected to have good fatigue properties and should not be prone to low temperature cracking.

Since EAM has a higher structural equivalency than granular base material, it is suitable for pavement strengthening purposes where aggregate availability is low or where elevation restrictions exist.

This specification requires that the EAM be paver laid, i.e., be placed by a self-propelled mechanical paver. If an Owner would like the EAM to be grader laid, i.e., to allow the use of a grader to place the EAM, a special provision to allow that option should be included in the Contract Documents.

When additional full-depth reclamation is required beyond the limits of the expanded asphalt stabilization, the depth and limits of full-depth reclamation should be clearly indicated in the Contract Documents. (331.07.02)

Appendix 331-A

When compaction is to be determined according to OPSS 501 Method B, a minimum roller size should be specified.

A minimum 2-Day curing period is recommended prior to overlaying the EAM. The EAM should be surfaced as soon as possible after curing, as the mix is susceptible to damage by traffic and rain.

A tack coat is recommended on the EAM prior to hot mix overlay.

EAM is typically overlain with hot mix asphalt. A surface treatment or slurry surfacing may be considered; however, this specification may require modification.

Contract scheduling should allow for stabilization and overlay to be completed within the hot mix temperature operational constraints.

QC requirements have been removed from this specification, as acceptance is based on QA testing. If an Owner requires Contractor QC to confirm that the work meets the specification requirements, a special provision detailing the required Contractor QC should be included in the Contract Documents.

The payment clause for this specification is all inclusive. Should an Owner desire to pay for corrective aggregate, active filler, or asphalt cement separately, separate payment items are required.

In times of volatile asphalt cement prices, on multi-year contracts, and on Contracts with greater than 1,000 tonnes of paver laid EAM material, designers may consider using the MTO PGAC price index for payment adjustment. The MTO PGAC price index is available on the Ontario Ministry of Transportation website at www.raqs.mto.gov.on.ca, by clicking on Contractor, Contract Bulletin, Asphalt Price Index. The MTO PGAC price index is only a tool for qualifying PGAC prices and is not intended as a standard asphalt cement price to be incorporated into the contract bid. The MTO PGAC price index calculation for a given month takes in the average of the 4 weeks of the month and is published on the last day of the month.

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

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR COLD IN-PLACE RECYCLED MIX

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 corrective aggregate or active filler or both, if required; adding and mixing of emulsified asphalt; and spreading and compacting the cold in-place recycled (CIR) mix.

333.01.01 Specification Significance and Use

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

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

333.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

333.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 310 Hot Mix Asphalt

Ontario Provincial Standard Specifications, Material

OPSS 1003 Aggregates - Hot Mix Asphalt
OPSS 1103 Emulsified Asphalt
OPSS 1301 Cementing Materials

Ontario Ministry of Transportation Publications

MTO Laboratory Testing Manual:

LS-200 Penetration of Bituminous Materials
LS-291 Quantitative Extraction of Asphalt Cement and Mechanical Analysis of Extracted Aggregate from Bituminous Paving Mixtures - Ontario Procedure
LS-300 Preparation of Marshall Specimens for Cold In-Place Recycled Mixtures
LS-306 Bulk Relative Density of Compacted Bituminous Mixtures Using Paraffin-Coated Specimens
LS-602 Sieve Analysis of Aggregates
LS-625 Sampling of Granular Materials

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

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

ASTM International

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

333.03 DEFINITIONS

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

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

AMRL means as defined in OPSS 310.

CCIL means as defined in OPSS 310.

Cold In-Place Recycled (CIR) Mix means the in-place mixture of existing reclaimed HMA pavement, corrective aggregate or active filler or both if required, emulsified asphalt, and water.

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

Hot Mix Asphalt (HMA) means as defined in OPSS 310.

Quality Assurance (QA) means as defined in OPSS 310.

Quality Control (QC) means as defined in OPSS 310.

Reclaimed Asphalt Pavement (RAP) means as defined in OPSS 310.

Segregation means a condition of the pavement characterized by areas with comparatively coarser or finer texture than that of the surrounding pavement. Longitudinal streak is segregation that manifests itself as a longitudinal mark on the pavement mat.:

- a) **Slight Segregation** means the pavement matrix is in place between the coarse aggregate particles; however, there are slightly more coarse aggregate particles in comparison with the surrounding acceptable mix.
- b) **Medium Segregation** means the pavement has significantly more coarse aggregate particles than the surrounding acceptable mat and usually exhibits some lack of surface matrix. Some coarse aggregate particle to coarse aggregate particle contact may also exist.
- c) **Severe Segregation** means the pavement appears very coarse, predominantly with coarse aggregate particle to coarse aggregate particle contact and the pavement has little or no matrix.

Target Density means the average Bulk Relative Density for the lot established according to LS-300, and used to determine the per cent Compaction.

333.04 DESIGN AND SUBMISSION REQUIREMENTS

333.04.01 Design Requirements

For mix design purposes, prior to commencing the work samples representative of the material that is

produced during the milling operation shall be obtained. These samples shall be used to establish the design rate of emulsified asphalt as a percent by mass of the RAP. The design rate of the emulsified asphalt shall be a minimum of 1.2%.

The mix design shall be completed by a laboratory with CCIL Type A certification or equivalent equipped to carry out CIR mix design. When the existing pavement significantly changes composition, a separate mix design shall be completed.

Each mix design shall include the following:

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

333.04.02 Submission Requirements

The mix design shall be submitted to the Contract Administrator a minimum of 7 Days prior to the start of CIR operations. When more than one mix design is required, the area for which each mix design is to be used shall be clearly identified.

A new mix design shall be submitted when the emulsified asphalt design rate is adjusted by greater than 0.2%. Separate or new mix designs shall be submitted if the composition or layer thicknesses or both of the existing pavement changes significantly.

333.05 MATERIALS

333.05.01 Active Filler

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

When used as active filler, Portland cement shall be according to OPSS 1301. No more than 1% by mass of Portland cement shall be added to the mix.

333.05.02 Corrective Aggregate

If required by the mix design, corrective aggregate shall be incorporated into the reclaimed existing asphalt pavement at the application rate determined in the mix design. Corrective aggregate shall meet the physical and consensus property requirements of OPSS 1003 for the coarse and fine aggregates of Superpave 19.0 binder course.

333.05.03 Emulsified Asphalt

Emulsified asphalt shall be mixing grade meeting the requirements of OPSS 1103, and be compatible with the process and materials used. The addition of polymer modification shall be as specified in the Contract Documents.

333.05.04 Reclaimed Asphalt Pavement

RAP material shall be 100% passing the 37.5 mm sieve and 95 to 100% passing the 26.5 m sieve after processing, as per LS-602.

333.05.05 Water

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

333.06 EQUIPMENT

333.06.01 Recycling Train

The recycling train shall include the following:

- a) A self-propelled cold milling unit with a cutting drum capable of reclaiming a full lane width of asphalt pavement to the depth specified in the Contract Documents in one pass.
- b) A sizing unit capable of processing the RAP to meet the requirements of this specification.
- c) An aggregate feed system that measures and regulates the mass of RAP being added into the mixing unit prior to the addition of the emulsified asphalt. The scale shall be calibrated to the manufacturer's tolerance at the start of the Contract and when requested by the Contract Administrator.
- d) An emulsified asphalt control system equipped with a flow meter calibrated in litres per tonne and a total delivery meter calibrated in litres to continuously maintain the required amount of emulsified asphalt added to within 0.2% by mass of the reclaimed material feed.
- e) A means of monitoring and controlling the addition of water.
- f) A mixing unit equipped with a device capable of producing a uniform and thoroughly blended CIR mix.

Alternative equipment may be considered subject to approval by the Contract Administrator and demonstration of meeting the requirements of the Cold In-Place Recycling Trial Section subsection.

333.06.02 Placing Equipment

Placing of the CIR mix shall be carried out by means of a self-propelled mechanical paver capable of spreading the mix evenly in front of the screed in one continuous pass to the specified crossfall and grade. The paver shall be equipped with distributing augers for the full width to be paved. The paver shall have a vibratory screed capable of vibrating the full width of mix placed.

333.06.03 Compaction Equipment

Appropriate compaction equipment to achieve the required compaction shall be used.

333.06.04 Drying Unit

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

333.06.05 Pilot Vehicle

The pilot vehicle shall be according to the requirements of the OTM, Book 7.

333.06.06 Straight Edge

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

333.07 CONSTRUCTION

333.07.01 General

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

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

333.07.02 Operational Constraints

The work shall not be carried out when the ambient temperature is less than 10 °C or when the overnight low is forecast to be less than 2 °C. CIR shall not be placed after September 1st without written approval from the Contract Administrator. The work shall be carried out when the roadway is clean and free of standing water. CIR shall not proceed in the rain.

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

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

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

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

333.07.03 Cold In-Place Recycling Trial Section

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

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

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

The Contract Administrator shall allow the CIR work to continue based on an acceptable visual assessment of the trial according to the requirements of the Surface Appearance subsection. When the CIR is rejected by visual assessment, additional trial sections shall be completed until the CIR meets the requirements of this specification.

Unacceptable trial sections shall be repaired, removed, or replaced, as required.

333.07.04 Surface Preparation

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

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

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

333.07.05 Mixing

The emulsified asphalt shall be added at the design rate. The rate of addition of emulsified asphalt shall be field adjusted as required to within 0.20% of the design rate and mixed to produce a uniformly coated CIR mix that can be compacted to the specified density. The minimum percent of emulsified asphalt added shall be 1.2%.

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

333.07.06 Compaction

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

333.07.07 Surface Appearance

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

333.07.08 Drying

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

333.07.09 Sampling

333.07.09.01 General

Holes resulting from the removal of samples shall be repaired according to the sampling provisions of OPSS 310, using acceptable binder course HMA or other material approved by the Contract Administrator.

333.07.09.02 Cold In-Place Recycling Material

At least 4 Business Days prior to the planned overlay of the CIR mat, 2 slab samples of the CIR material shall be obtained for each area taken at random locations, as directed by the Contract Administrator:

One slab sample shall be used to test for moisture content and the other shall be used to test for compaction. Each slab sample shall be dry cut 150 x 150 mm and removed intact from the CIR mat.

The samples shall be packaged in non-absorptive materials to protect sample integrity, sealed in waterproof containers, appropriately labelled, and delivered in good condition within 48 hours of sampling to the designated QA testing laboratory specified in the Contract Documents.

Additional slab samples to test for compaction and moisture content shall only be taken once remedial work has been carried out to improve compaction in the failed areas. The Contractor shall be charged the cost of additional testing.

At the start of production for each location in a Contract, or whenever the existing pavement material significantly changes composition within a location in a Contract, 15 kg of material reclaimed from the roadway after adding emulsion shall be obtained for the purpose of determining target density. Samples shall be taken at random locations as directed by the Contract Administrator.

The Contractor shall be permitted to carry out QC sampling and testing of the CIR mat.

333.07.09.03 Emulsified Asphalt

For information purposes, samples of emulsified asphalt used in the mix shall be taken at the job site from each tanker load of material used on the Contract. Each sample shall be taken either from a sampling spigot on the transfer line, if available, or from the end of the transfer line after a minimum of 4,000 kg has been drawn from the tanker. Each set of samples shall be a minimum of 2 full four-litre containers.

Samples of the emulsified asphalt used in the mix shall be obtained, properly labelled and identified, and delivered to the designated QA testing laboratory.

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

333.07.09.04 Corrective Aggregate

The Contract Administrator may request samples of the corrective aggregate to demonstrate conformance to the requirements of this specification. When requested, two 25 kg samples shall be taken in the presence of the Contract Administrator.

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

Samples of the corrective aggregate shall be obtained, properly labeled and identified, and delivered within 48 hours of sampling to the designated QA testing laboratory as specified in the Contract Documents.

333.07.09.05 Active Filler

The Contract Administrator may take samples of active filler to demonstrate conformance to the requirements of this specification.

333.07.10 Traffic Convoy

Traffic shall be convoyed according to the OTM, Book 7.

The pilot vehicle shall guide one-way traffic through or around construction. The maximum speed of the convoy shall be 30 km/h. Convoying shall be maintained until such time as the CIR mat is able to carry traffic without damage.

333.07.11 Management of Excess Material

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

333.08 QUALITY ASSURANCE

333.08.01 General

Acceptance shall be based on QA testing. QA testing shall be carried out at a laboratory currently certified by CCIL with Type A or Type B certification or AMRL accredited or equivalent laboratory.

The Contract Administrator shall reject all unacceptable material and all visually defective material, mix, or work shown in Table 1. Defective material, mixture, and work shall not be incorporated into the finished work.

If the CIR does not meet the requirements of the specification within 30 Days after placing the CIR mat, it shall be deemed unacceptable.

333.08.02 Surface Tolerance

After compaction, the surface of the CIR mat shall be free from deviations exceeding 6 mm, as measured in any direction with a 3 m straight edge.

333.08.03 Acceptance Criteria for Moisture Content

Acceptance criteria shall be based on the QA test results for each location in the Contract.

The moisture content shall be determined according to LS-291. The average moisture content for each location in a Contract placed shall be 2.0% or less, with no individual test for the location exceeding 3.0%.

The CIR mix that does not meet moisture content requirements shall be deemed unacceptable.

333.08.04 Acceptance Criteria for Compaction

Acceptance criteria shall be based on the QA test results for each area represented by a set of slab samples and the Target Density established for that area.

The CIR mix shall be compacted to a minimum of 96% of the Target Density.

Compaction shall be calculated for area of CIR represented by a set of slab sample from the bulk relative density determined from slab samples according to LS-306 or ASTM D 6752 and the Target Density as follows:

Compaction = (bulk relative density of slab sample / Target Density) x 100%

The Target Density shall be established according to LS-300.

CIR that is not compacted to the required density shall be deemed unacceptable.

333.08.05 Acceptance of Corrective Aggregate

QA testing shall be carried out to ensure that corrective aggregate to be used in the work is according to the physical and consensus property requirements of OPSS 1003 for the coarse and fine aggregates of Superpave 19.0 binder course.

333.08.06 Repair of Unacceptable Cold In-Place Recycled Mat

The CIR mat that is unacceptable shall be repaired as specified in Table 1.

Repairs shall be for the full lane width and a minimum length of 15 m to the depth shown in Table 1.

The HMA required to repair unacceptable CIR shall be placed in compacted lift thickness between 40 to 75 mm.

The HMA mix type and design used for repairs shall be approved by the Contract Administrator and shall meet the acceptance requirements for the HMA specified elsewhere in the Contract Documents.

333.09 MEASUREMENT FOR PAYMENT

333.09.01 Actual Measurement

333.09.01.01 Cold In-Place Recycled Mix

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

333.09.02 Plan Quantity Measurement

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

333.10 BASIS OF PAYMENT

333.10.01 Cold In-Place Recycled Mix - Item

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

The addition of corrective aggregate or active filler to the mix shall be at no extra cost to the Owner.

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

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

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

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

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

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

TABLE 1
Unacceptable CIR Mix and Required Repair

Defect Type	Severity	Required Repair
Ravelling/Coarse Aggregate Loss (Note 1)	Very Slight to Slight	No action required.
	Moderate to Severe	Mill 50 mm and replace with an acceptable binder course HMA (Note 3).
	Very Severe	Remove CIR to full depth and replace with an acceptable binder course HMA (Note 3).
Segregation (Note 2)	Slight to Medium	No action required.
	Severe	Mill 50 mm and replace with an acceptable binder course HMA (Note 3).
Moisture content could not be achieved as per the Acceptance Criteria for Moisture Content subsection.	N/A	Remove CIR material to full depth represented by the test and replace with an acceptable binder course HMA (Note 3).
Compaction could not be achieved as per the Acceptance Criteria for Compaction subsection.	N/A	Remove CIR material to full depth represented by the test and replace with an acceptable binder course HMA (Note 3).
Notes: 1. Defect and severity definitions according to SP-027. 2. Defect and severity definitions according to Definitions section of this specification. 3. Reprocessing may be considered as a repair method, upon submission of a proposal by the Contractor and approved by the Contract Administrator.		

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

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

Designer Action/Considerations

Cold in-place recycling (CIR) is suitable for treating a wide range of pavement distresses. CIR can repair pavements exhibiting age, thermal, fatigue, or reflective cracking and previously recycled pavements and is beneficial in mitigating reflective cracking. CIR is not suitable for pavements with extensive base or subbase problems, pavements containing steel slag, or pavements of insufficient strength.

The designer should specify the following in the Contract Documents:

- The addition of polymer modified may be considered to enhance additional performance (333.05.03)
- Depth of CIR. (333.07.01)
- Crossfall and grade. (333.07.07)
- Testing laboratory to carry out CIR moisture content and compaction testing. (333.07.09.02)
- Testing laboratory to carry out corrective aggregate testing. (333.07.09.04)

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

- Additional items for milling or padding or both if significant crossfall deficiencies (> 1%) exist in the existing pavement surface. (333.07.04)

It is recommended that adequate pre-engineering be carried out on the project and that existing pavement thicknesses and composition be established. Additional investigation should be carried out where pavement composition changes, such as patched areas. Pre-engineering data should be included in the Contract Documents.

Corrective aggregates are used when existing pavements are experiencing rutting, shoving, or flushing and it is suspected that the existing bituminous material is the cause of these distresses. Corrective aggregate may also be required to achieve mix design properties.

Any full depth repairs required for frost heave and distortion corrections should be repaired prior to CIR.

In urban areas, the designer should be aware of appurtenance adjustment requirements, curb heights, and accessibility concerns to accommodate the CIR equipment train and the requirement for traffic detours.

Contract scheduling should allow for CIR and follow-up paving to be completed within the time, temperature, and operational constraints.

The designer should be aware that severe distresses (e.g., significant alligator cracking, map cracking) may create an abundance of oversize material and remediation (e.g., pre-milling, pre-pulverizing) that may need to be addressed to meet gradation requirements.

Appendix 333-A

The designer should be aware that the length of CIR paving operation may affect traffic management.

CIR treatment depths typically range from 75 to 125 mm. The depth of CIR treatment shall be selected to minimize disturbance of the underlying granular base. It is recommended to have at least 25 mm of remaining HMA pavement below the CIR.

CIR is typically overlaid with HMA wearing course. Surface treatment, slurry surfacing, or microsurfacing may be considered.

A tack coat is recommended prior to paving HMA wearing course.

QC requirements have been removed from this specification, as acceptance is based on QA testing. If an Owner requires Contractor QC to confirm that the work meets the specification requirements, a special provision detailing the required Contractor QC should be included in the Contract Documents.

The payment clause for this specification is all inclusive. Should a municipality desire to pay for corrective aggregate, active filler, or emulsified asphalt separately, separate payment items are required.

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

Related Ontario Provincial Standard Drawings

No information provided here.



**ONTARIO
PROVINCIAL
STANDARD
SPECIFICATION**

**METRIC
OPSS.MUNI 335
NOVEMBER 2015**
(Formerly OPSS 335, November 2013)

**CONSTRUCTION SPECIFICATION FOR
COLD IN-PLACE RECYCLED EXPANDED ASPHALT MIX**

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

335.01.01 Specification Significance and Use

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

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

335.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

335.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 310 Hot Mix Asphalt

Ontario Provincial Standard Specifications, Material

OPSS 1003 Aggregates - Hot Mix Asphalt
OPSS 1101 Performance Graded Asphalt Cement
OPSS 1301 Cementing Materials

Ontario Ministry of Transportation Publications

MTO Laboratory Testing Manual:

LS-200 Penetration of Bituminous Materials
LS-297 Determination of Indirect Tensile Strength of Expanded Asphalt Mixes
LS-306 Bulk Relative Density of Compacted Bituminous Mixtures Using Paraffin-Coated Specimens
LS-625 Sampling of Granular Materials

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

SP-024 Manual for the Condition Rating of Flexible Pavements

ASTM International

D 6752-09 Standard Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Automatic Vacuum Sealing Method

Wirtgen GmbH Publication

Wirtgen Cold Recycling Technology manual, 3rd edition, 2010

335.03 DEFINITIONS

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

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

AMRL means as defined in OPSS 310.

CCIL means as defined in OPSS 310.

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

Corrective Aggregate means virgin aggregate or reclaimed asphalt pavement (RAP) or both added to the reclaimed existing asphalt pavement to meet the CIREAM requirements.

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 310.

Performance Graded Asphalt Cement (PGAC) as defined in OPSS 310.

Quality Assurance (QA) means as defined in OPSS 310.

Quality Control (QC) means as defined in OPSS 310.

Reclaimed Asphalt Pavement (RAP) means as defined in OPSS 310.

Segregation means as defined in OPSS 310 and includes the following severities:

- a) **Slight Segregation** means the pavement matrix is in place between the coarse aggregate particles; however, there are slightly more coarse aggregate particles in comparison with the surrounding acceptable mix.
- b) **Medium Segregation** means the pavement has significantly more coarse aggregate particles than the surrounding acceptable mat and usually exhibits some lack of surface matrix.
- c) **Severe Segregation** means the pavement appears very coarse, with coarse aggregate particle against coarse aggregate particle and the pavement has little or no matrix.

335.04**DESIGN AND SUBMISSION REQUIREMENTS****335.04.01****Design Requirements**

For mix design purposes, prior to commencing the work the Contractor shall obtain samples representative of the material that is produced during the milling operation. These samples shall be used to establish the design rate of expanded asphalt as a percent by mass of the RAP. The design rate of the expanded asphalt shall be a minimum of 1.0%. The dry tensile strength shall be a minimum of 225 kPa and the wet tensile strength shall be a minimum of 100 kPa. The tensile strength ratio shall be a minimum of 50%.

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

Each mix design shall include the following:

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

335.04.02**Submission Requirements**

The mix design shall be submitted by the Contractor to the Contract Administrator a minimum of 7 Days prior to the start of CIREAM operations. When more than one mix design is required, the area for which each mix design is to be used shall be clearly identified.

A new mix design shall be submitted when the expanded asphalt design rate is adjusted by greater than 0.2%. Separate or new mix designs shall be submitted if the composition or layer thicknesses or both of the existing pavement changes significantly.

335.05 MATERIALS

335.05.01 Active Filler

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

When used as active filler, Portland cement shall be according to OPSS 1301. No more than one percent by mass of Portland cement shall be added to the mix.

335.05.02 Corrective Aggregate

If required by the mix design, corrective aggregate shall be incorporated into the reclaimed existing asphalt pavement at the application rate determined in the mix design. Corrective aggregate shall meet the physical and consensus property requirements of OPSS 1003, with the exception of the sand equivalent test, for the coarse and fine aggregates of Superpave 19.0 binder course.

335.05.03 Performance Graded Asphalt Cement

The Contractor shall select a PGAC with suitable expansion characteristics. PGAC shall be according to OPSS 1101, excluding PGAC zone requirements.

335.05.04 Reclaimed Asphalt Pavement

RAP material shall be 100% passing the 37.5 mm sieve and 95 to 100% passing the 26.5 mm sieve after processing.

335.05.05 Water

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

335.06 EQUIPMENT

335.06.01 Recycling Train

The recycling train shall include the following:

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

- f) A mixing unit equipped with a device capable of producing a uniform and thoroughly blended CIREAM.

Alternative equipment may be considered subject to approval by the Contract Administrator and demonstration of meeting the requirements of the Cold In-Place Recycled Expanded Asphalt Trial Section subsection.

335.06.02 Placing Equipment

Placing of the CIREAM shall be carried out by means of a self-propelled mechanical paver capable of spreading the mix evenly in front of the screed in one continuous pass to the specified crossfall and grade. The paver shall be equipped with distributing augers for the full width to be paved. The paver shall have a vibratory screed capable of vibrating the full width of mix placed.

335.06.03 Compaction Equipment

The Contractor shall select the appropriate compaction equipment to achieve the required compaction.

335.06.04 Pilot Vehicle

The pilot vehicle shall be according to the requirements of the OTM, Book 7.

335.06.05 Straight Edge

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

335.07 CONSTRUCTION

335.07.01 General

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

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

335.07.02 Operational Constraints

CIREAM shall not be placed after September 1st without written approval from the Contract Administrator.

The work shall be carried out when the roadway is clean and free of standing water. CIREAM shall not proceed in the rain.

All traffic, including construction traffic, shall be kept off the freshly placed CIREAM mat until it is able to carry traffic without damage. The Contractor shall be responsible for repair of the damaged CIREAM mat.

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

- a) The CIREAM mat has been opened to traffic and allowed to cure for a minimum of 3 Days.
- b) The specified tensile strength has been achieved according to the Quality Assurance section.
- c) The specified density has been achieved according to the Compaction subsection.

- d) All defective areas in the CIREAM mat have been repaired to the satisfaction of the Contract Administrator.

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

335.07.03 Cold In-Place Recycled Expanded Asphalt Trial Section

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

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

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

The Contract Administrator shall allow the Contractor to continue the CIREAM work based on an acceptable visual assessment of the trial according to the requirements of the Surface Appearance subsection. When the CIREAM is rejected by visual assessment, the Contractor shall repeat additional trial sections until the CIREAM meets the requirements of this specification.

The Contractor shall be responsible for the repair, removal, or replacement of an unacceptable trial section.

335.07.04 Surface Preparation

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

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

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

335.07.05 Mixing

The expanded asphalt shall be added at the design rate. The rate of addition of expanded asphalt shall be field adjusted as required to within 0.20% of the design rate and mixed to produce a uniformly coated CIREAM that can be compacted to the specified density. The minimum percent of expanded asphalt added shall be 1.0%.

335.07.06 Compaction

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

335.07.07 Surface Appearance

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

335.07.08 Sampling

335.07.08.01 General

Holes resulting from the removal of samples shall be repaired according to the sampling provisions of OPSS 310, using an acceptable binder course HMA or other material approved by the Contract Administrator.

335.07.08.02 Cold In-Place Recycled Expanded Asphalt Mix

After placement and prior to compaction, the Contractor shall obtain one 15 kg sample of the CIREAM from each 5,000 m² placed, taken at random locations as directed by the Contract Administrator. The samples to be tested for acceptance of CIREAM shall be used to test for dry tensile strength, wet tensile strength, and tensile strength ratio according to LS-297.

Prior to the planned overlay of the CIREAM mat, the Contractor shall obtain 2 slab samples of the CIREAM from each 5,000 m² placed, to be taken at random locations as directed by the Contract Administrator. One slab sample shall be used to test for moisture content and the other shall be used to test for compaction. Each slab sample shall be dry cut 150 x 150 mm and removed intact from the CIREAM mat.

The samples shall be packaged in non-absorptive materials to protect sample integrity, sealed in waterproof containers, appropriately labelled, and delivered by the Contractor in good condition within 48 hours of sampling to the designated QA testing laboratory specified in the Contract Documents.

Additional slab samples to test for compaction shall only be taken once the Contractor has carried out remedial work to improve compaction in the failed areas. The Contractor shall be charged the cost of additional testing.

The Contractor shall be permitted to carry out QC sampling and testing of the CIREAM mat.

335.07.08.03 Corrective Aggregate

The Contract Administrator may request samples of the corrective aggregate to demonstrate conformance to the requirements of this specification. When requested, two 25 kg samples shall be taken in the presence of the Contract Administrator.

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

Samples of the corrective aggregate shall be obtained, properly labelled and identified, and delivered within 48 hours of sampling to the designated QA testing laboratory as specified in the Contract Documents.

335.07.08.04 Active Filler

The Contract Administrator may take samples of active filler to demonstrate conformance to the requirements of the Contract Documents.

335.07.09 Traffic Convoy

The Contractor shall convoy traffic according to the OTM, Book 7.

The pilot vehicle shall guide one-way traffic through or around construction. The maximum speed of the convoy shall be 30 km/h. Convoying shall be maintained until such time as the CIREAM mat is able to carry traffic without damage.

335.07.10 Management of Excess Material

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

335.08 QUALITY ASSURANCE

335.08.01 General

Acceptance shall be based on QA testing. QA testing shall be carried out by a laboratory currently certified by CCIL with Type A or Type B certification or AMRL accredited or equivalent laboratory.

Acceptance criteria shall be based on the QA test results for each 5,000 m² placed.

The Contract Administrator shall reject all unacceptable material and all visually defective-material, mix, or work as shown in Table 1. Defective material, mixture, and work shall not be incorporated into the finished work.

If the CIREAM does not meet the requirements of the specification within 30 Days after placing the CIREAM mat, it shall be deemed unacceptable.

335.08.02 Surface Tolerance

After compaction, the surface of the CIREAM mat shall be free from deviations exceeding 6 mm, as measured in any direction with a 3 m straight edge.

335.08.03 Acceptance Criteria for Compaction

The CIREAM shall be compacted to a minimum of 96% of the target density.

Compaction shall be calculated for each 5,000 m² placed from the bulk relative density determined from slab samples according to LS-306 or ASTM D 6752 and the target density as follows:

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

The target density to be used for acceptance purposes shall be calculated for each 5,000 m² placed by averaging the densities of 6 compacted specimens produced for indirect tensile strength testing according to LS-297.

335.08.04 Acceptance Criteria for Cold In-Place Recycled Expanded Asphalt Mix

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

Samples of CIREAM shall be tested for acceptance purposes in accordance with LS-297.

Dry tensile strength requirements for each 5,000 m² placed are met when the dry tensile strength of the sample is equal to or greater than 225 kPa.

Wet tensile strength requirements for each 5,000 m² placed are met when the wet tensile strength of the sample is equal to or greater than 100 kPa.

The tensile strength ratio for the individual samples shall not be less than 50%.

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

335.08.05 Acceptance of Corrective Aggregate

QA testing may be carried out to ensure that corrective aggregate to be used in the work is according to the physical and consensus property requirements of OPSS 1003, with the exception of the sand equivalent test, for the coarse and fine aggregates of Superpave 19.0 binder course.

335.08.06 Repair of Unacceptable CIREAM

CIREAM that is unacceptable shall be repaired as shown in Table 1.

Repairs shall be for the full lane width and minimum length of 15 m to the depth shown in Table 1.

The HMA required to repair unacceptable CIREAM shall be placed in compacted lift thickness between 40 to 75 mm.

The HMA mix type and design used for repairs shall be approved by the Contract Administrator and shall meet the acceptance requirements for the HMA specified elsewhere in the Contract Documents.

335.09 MEASUREMENT FOR PAYMENT

335.09.01 Actual Measurement

335.09.01.01 Cold In-Place Recycled Expanded Asphalt Mix

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

335.09.02 Plan Quantity Measurement

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

335.10 BASIS OF PAYMENT

335.10.01 Cold In-Place Recycled Expanded Asphalt Mix - Item

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

The addition of corrective aggregate or active filler to the mix shall be at no extra cost to the Owner.

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

PGAC shall be included in the CIREAM item.

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

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

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

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

TABLE 1
Unacceptable CIREAM and Required Repair

Defect Type	Severity	Required Repair
Ravelling/Coarse Aggregate Loss (Note 1)	Very Slight to Slight	No action required.
	Moderate to Severe	Mill 50 mm and replace with an acceptable binder course HMA (Note 3).
	Very Severe	Remove CIREAM to full depth and replace with an acceptable binder course HMA.
Segregation (Note 2)	Slight to Medium	No action required.
	Severe	Mill 50 mm and replace with an acceptable binder course HMA (Note 3).
Compaction is not achieved as per the Acceptance Criteria for Compaction subsection.	N/A	Remove CIREAM, to full depth, represented by the test and replace with an acceptable binder course HMA (Note 3).
Dry tensile strength, wet tensile strength, or tensile strength ratio is not achieved as per the Acceptance Criteria for Cold In-Place Recycled Expanded Asphalt Mix subsection.	N/A	Remove CIREAM, to full depth, represented by the test and replace with an acceptable binder course HMA (Note 3).
Notes: 1. Defect and severity definitions according to SP-024. 2. Defect and severity definitions according to Definitions section of this specification. 3. Reprocessing may be considered as a repair method, upon submission of a proposal by the Contractor and approval by the Contract Administrator.		

Appendix 335-A, November 2013 FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

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

Designer Action/Considerations

Cold in-place recycling with expanded asphalt (CIREAM) is suitable for treating a wide range of pavement distresses. CIREAM can repair pavements exhibiting age; thermal, fatigue, or reflective cracking and previously recycled pavements and is beneficial in mitigating reflective cracking. CIREAM is not suitable for pavements with extensive base or subbase problems, pavements containing steel slag, or pavements of insufficient strength.

The designer should specify the following in the Contract Documents:

- Depth of CIREAM. (335.07.01)
- Grade and crossfall. (335.07.07)
- Designated testing laboratory. (335.07.08.02, 335.07.08.03)

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

- Additional items for milling or padding or both if significant crossfall deficiencies exist in the existing pavement surface. (335.07.04)

It is recommended that adequate pre-engineering be carried out on the project and that existing pavement thicknesses and composition be established. Additional investigation should be carried out when pavement composition changes, such as patched areas. Pre-engineering data should be included in the Contract Documents.

Corrective aggregates are used when existing pavements are experiencing rutting, shoving, or flushing and it is suspected that the existing bituminous material is the cause of these distresses. Corrective aggregate may also be required to achieve mix design properties.

Any full depth repairs required for frost heave and distortion corrections should be repaired prior to CIREAM.

In urban areas, the designer should be aware of appurtenance adjustment requirements, curb heights, and accessibility concerns to accommodate the CIREAM equipment train and the requirement for traffic detours.

Contract scheduling should allow CIREAM and follow-up pavement to be completed within the time and operational constraints.

The designer should be aware that severe distresses (e.g., significant alligator cracking, map cracking) may create an abundance of oversize material and remediation (e.g., pre-milling, pre-pulverizing) needs to be addressed to meet gradation requirements.

The designer should be aware that the length of CIREAM paving operation may affect traffic management.

Appendix 335-A

It is recommended to have at least 25 mm of remaining HMA pavement below the CIREAM.

CIREAM is typically overlaid with a HMA wearing course. Surface treatment, slurry surfacing, or microsurfacing may be considered.

A tack coat is recommended prior to paving HMA wearing course.

QC requirements have been removed from this specification, as acceptance is based on QA testing. If an Owner requires Contractor QC to confirm that the work meets the specification requirements, a special provision detailing the required Contractor QC should be included in the Contract Documents.

The payment clause for this specification is all inclusive. Should a municipality desire to pay for corrective aggregate, active filler, or asphalt cement separately, separate payment items are required.

In times of volatile asphalt cement prices, on multi-year contracts, and on Contracts with greater than 1,000 tonnes of paver laid CIREAM material, designers may consider using the MTO PGAC price index for payment adjustment. The MTO PGAC price index is available on the Ontario Ministry of Transportation website at www.raqs.mto.gov.on.ca, by clicking on Contractor, Contract Bulletin, Asphalt Price Index. The MTO PGAC price index is only a tool for qualifying PGAC prices and is not intended as a standard asphalt cement price to be incorporated into the contract bid. The MTO PGAC price index calculation for a given month takes in the average of the 4 weeks of the month and is published on the last day of the month.

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

Related Ontario Provincial Standard Drawings

No information provided here.



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

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

401.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

401.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Construction

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

Ontario Provincial Standard Specifications, Material

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

Provincial Statute

Occupational Health and Safety Act

R.S.O. 1990,

c. O.1, as amended

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

401.03 DEFINITIONS

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Trench means the definition as provided in the *Occupational Health and Safety Act* and Regulations for Construction Projects.

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

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

Unshrinkable Fill means as defined in OPSS 1359.

401.05 MATERIALS

401.05.01 Embedment Material

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

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

401.05.02 Bedding Material

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

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

401.05.03 Cover Material

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

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

401.05.04 Granular Material

Granular material shall be according to OPSS 1010.

401.05.05 Backfill Material

401.05.05.01 General

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

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

401.05.05.02 Native and Imported Material

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

401.05.06 Unshrinkable Fill

Unshrinkable fill shall be according to OPSS 1359.

401.07 CONSTRUCTION

401.07.01 General

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

401.07.02 Site Preparation

Site preparation shall be according to OPSS 490.

401.07.03 Preservation and Protection of Existing Facilities

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

401.07.04 Removals

Removals shall be according to OPSS 510.

401.07.05 Dewatering

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

401.07.06 Support Systems

Support systems shall be according to OPSS 404.

401.07.07 Temporary Protection Systems

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

401.07.08 Removal of Frozen Ground

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

401.07.09 Trenching

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

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

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

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

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

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

Rock excavation for trenches shall be according to OPSS 403.

401.07.10 Backfilling and Compacting

401.07.10.01 General

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

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

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

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

401.07.10.02 Embedment

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

401.07.10.03 Bedding

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

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

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

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

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

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

401.07.10.04 Cover

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

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

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

401.07.10.05 Backfill

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

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

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

401.07.11 Additional Trenching, Backfilling, and Compacting

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

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

401.07.12 Site Restoration

Site restoration shall be according to OPSS 492.

401.07.13 Management of Excess Material

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

401.09 MEASUREMENT FOR PAYMENT

401.09.01 Actual Measurement

401.09.01.01 Additional Trenching, Backfilling, and Compacting

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

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

401.10 BASIS OF PAYMENT

401.10.01 Trenching, Backfilling, and Compacting

Payment at the Contract price for the appropriate tender items for the installation of sanitary and storm pipe sewers, pipe culverts and end sections, subdrains, forcemains and associated appurtenances, watermain and associated appurtenances, and other underground Utilities shall be full compensation for all labour, Equipment, and Material to do the work.

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

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

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

401.10.02 Additional Trenching, Backfilling, and Compacting - Item

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

401.10.03 Rock Excavation for Trenches

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

Appendix 401-A, November 2013

FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

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

Designer Action/Considerations

The designer may consider including soil boring data, a geotechnical report, a subsurface report, or a soils report in the tender documents.

The designer may consider specifying requirements for a pre-condition survey in the Contract Documents.

The designer should specify the following in the Contract Documents:

- Type of embedment material. (401.05.01)
- Type of bedding material. (401.05.02)
- Type of cover material. (401.05.03)
- Type of backfill material. (401.05.05.01)
- Trench line, grade, and dimensions. (401.07.09)
- Pipe bedding class and dimensions. (401.07.10.03)

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

Related Ontario Provincial Standard Drawings

OPSD 802.010	Flexible Pipe Embedment and Backfill, Earth Excavation
OPSD 802.013	Flexible Pipe Embedment and Backfill, Rock Excavation
OPSD 802.014	Flexible Pipe Embedment in Embankment, Original Ground: Earth or Rock
OPSD 802.020	Flexible Pipe Arch Embedment and Backfill, Earth Excavation
OPSD 802.023	Flexible Pipe Arch Embedment and Backfill, Rock Excavation
OPSD 802.024	Flexible Pipe Arch Embedment in Embankment, Original Ground: Earth or Rock
OPSD 802.030	Rigid Pipe Bedding, Cover and Backfill, Type 1 or 2 Soil - Earth Excavation
OPSD 802.031	Rigid Pipe Bedding, Cover and Backfill, Type 3 Soil - Earth Excavation
OPSD 802.032	Rigid Pipe Bedding, Cover and Backfill, Type 4 Soil - Earth Excavation
OPSD 802.033	Rigid Pipe Bedding, Cover and Backfill, Rock Excavation
OPSD 802.034	Rigid Pipe Bedding and Cover in Embankment, Original Ground: Earth or Rock
OPSD 802.050	Horizontal Elliptical Rigid Pipe Bedding, Cover and Backfill, Type 1 or 2 Soil - Earth Excavation
OPSD 802.051	Horizontal Elliptical Rigid Pipe Bedding, Cover and Backfill, Type 3 Soil - Earth Excavation
OPSD 802.052	Horizontal Elliptical Rigid Pipe Bedding, Cover and Backfill, Type 4 Soil - Earth Excavation
OPSD 802.053	Horizontal Elliptical Rigid Pipe Bedding, Cover and Backfill, Rock Excavation
OPSD 802.054	Horizontal Elliptical Rigid Pipe Bedding and Cover in Embankment, Original Ground: Earth or Rock
OPSD 803.010	Backfill and Cover for Concrete Culverts
OPSD 803.030	Frost Treatment - Pipe Culverts, Frost Penetration Line Below Bedding Grade
OPSD 803.031	Frost Treatment - Pipe Culverts, Frost Penetration Line Between Top of Pipe and Bedding Grade



CONSTRUCTION SPECIFICATION FOR 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 of storm and sanitary pipe sewers, laterals, service connections, and concrete appurtenances in open cut.

410.01.01 Specification Significance and Use

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

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

410.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

410.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Construction

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

Ontario Provincial Standard Specifications, Material

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

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

CSA Standards

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

ASTM International

C 507-12 Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe

410.03 DEFINITIONS

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

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

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

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

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

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

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

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

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

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

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

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

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

410.05 MATERIALS

410.05.01 Pipe Materials

410.05.01.01 General

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

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

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

410.05.01.02 Concrete Pipe

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

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

410.05.01.03 Corrugated Steel Pipe Products

Corrugated steel pipe products shall be according to OPSS 1801.

410.05.01.04 Polyethylene Pipe Products

Polyethylene pipe products shall be according to OPSS 1840.

410.05.01.05 Polyvinyl Chloride Pipe Products

Polyvinyl chloride pipe products shall be according to OPSS 1841.

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

410.05.01.06 Polypropylene Plastic Pipe Products

Polypropylene plastic pipe products shall be according to OPSS 1843.

410.05.02 Mortar

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

410.05.03 Clay Seal

Clay seal material shall be according to OPSS 1205.

410.05.04 Concrete

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

410.05.05 Steel Reinforcement

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

410.05.06 Geotextile

Geotextile shall be according to OPSS 1860.

410.07 CONSTRUCTION

410.07.01 Site Preparation

Site preparation shall be according to OPSS 490.

410.07.02 Removals

Removals shall be according to OPSS 510.

410.07.03 Preservation and Protection of Existing Facilities

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

410.07.04 Protection Against Floatation

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

410.07.05 Cold Weather Work

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

410.07.06 Transporting, Unloading, Storing, and Handling Pipe

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

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

410.07.07 Excavation

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

410.07.08 Support Systems

Support systems shall be according to OPSS 404.

410.07.09 Dewatering

Dewatering shall be according to OPSS 517.

410.07.10 Protection Systems

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

410.07.11 Backfilling and Compacting

Backfilling and compacting shall be according to OPSS 401.

410.07.12 Pipe Installation

410.07.12.01 General

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

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

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

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

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

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

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

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

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

410.07.12.02 Circular Concrete Pipe

All circular concrete pipe joints shall have elastomeric gaskets.

410.07.12.03 Non-Circular Concrete Pipe

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

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

410.07.12.04 Corrugated Steel Pipe Products

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

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

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

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

410.07.12.05 Polyethylene Pipe

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

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

410.07.12.06 Polyvinyl Chloride Pipe

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

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

410.07.12.07 Polypropylene Pipe

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

410.07.13 Service Connections

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

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

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

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

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

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

410.07.14 Marking and Recording Service Connections

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

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

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

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

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

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

410.07.16 Field Testing

410.07.16.01 General

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

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

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

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

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

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

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

410.07.16.02 Prequalification Leakage Tests

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

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

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

410.07.16.03 Infiltration Test

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

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

410.07.16.04 Exfiltration Test

410.07.16.04.01 General

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

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

410.07.16.04.02 Testing With Water

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

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

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

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

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

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

410.07.16.04.03 Low Pressure Air Testing

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

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

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

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

The air pressure shall be stabilized for five minutes and then regulated to maintain it to 20.5 kPa plus the allowance for groundwater, if any. After the stabilization period, the time taken for a pressure loss of 3.5 kPa shall be recorded.

The time taken for a pressure drop of 3.5 kPa shall not be less than the times shown in Table 1.

If the length of the test section is greater than the length for minimum time, the new testing time shall be a product of the length of test section multiplied by the time shown in Table 1 for the appropriate size pipe.

If the results of an air test are marginal, the Contract Administrator may require the section to be retested using water.

410.07.16.05 Deflection Testing of Pipe Sewers

Ring deflection testing shall be performed on all pipe sewers constructed using flexible pipe. The allowable deflected pipe diameter is calculated as:

Pipes 100 to 750 mm:	7.5% of the Base Inside Diameter of the Pipe
Pipes Greater Than 750 mm:	5.0% of the Base Inside Diameter of the Pipe

Where:

Base Inside Diameter is defined in the CSA or ASTM standard to which the pipe is manufactured.

A suitably designed device as defined below shall be pulled through the pipe sewer to demonstrate that the pipe deflection does not exceed the allowable deflected pipe diameter. The device shall be pulled manually through the pipe not sooner than 30 Days after the completion of backfilling and installation of service connections.

The suitably designed device shall be a mandrel, cylindrical in shape, and constructed with an odd number of evenly spaced arms or prongs, minimum 9 in number. The minimum diameter of the circle scribed around the outside of the mandrel arms shall be equal to the allowable deflected pipe diameter ± 1 mm. The contact length of the mandrel shall be measured between the points of contact on the mandrel arm or between sets of prongs. This length shall not be less than that shown in Table 2.

The mandrel shall be checked with a go-no-go proving ring. The proving ring shall have a diameter equal to the allowable deflected pipe diameter ± 0.1 mm. An acceptable mandrel shall not pass through the proving ring. The proving ring shall be fabricated from steel a minimum of 6 mm thick.

Any section of pipe that does not allow the mandrel to pass shall be considered to have failed the deflection test.

All sections of pipe that fail the deflection test shall be repaired and retested.

410.07.16.06 Closed-Circuit Television (CCTV) Inspection

Pipe sewers shall be inspected using CCTV equipment. CCTV inspection of pipe sewers shall be according to OPSS 409.

410.07.17 Cleaning and Flushing of Pipe Sewers

When specified in the Contract Documents, all pipe sewers shall be cleaned and flushed immediately prior to inspection and acceptance.

410.07.18 Clay Seals

Clay seals shall be placed as specified in the Contract Documents and compacted to 95% of the maximum dry density.

410.07.19 Concrete Appurtenances

Concrete appurtenances shall be constructed as specified in the Contract Documents. Concrete in concrete appurtenances shall be placed according to OPSS 904. Steel reinforcement shall be placed according to OPSS 905. Steel grating shall be installed when specified in the Contract Documents.

410.07.20 Site Restoration

Site restoration shall be according to OPSS 492.

410.07.21 Management of Excess Material

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

410.09 MEASUREMENT FOR PAYMENT

410.09.01 Actual Measurement

410.09.01.01 Pipe Sewers

Measurement of pipe sewers shall be by length in metres along the horizontal centreline length of the pipe from the centre of one drainage structure to the centre of another drainage structure or outlet end of the pipe sewer. When the grade of the pipe sewer is 10% or greater, the above measurement is then of the slope length.

410.09.01.02 Service Connections

Measurement of the service connections shall be by length in metres along its horizontal centreline from the centreline of the main pipe sewer to the end of the service connection.

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

For measurement purposes, a count shall be made of the number of openings made in maintenance holes, catch basins, ditch inlets, pipe culverts and pipe sewers.

410.09.01.04 Concrete Appurtenances

Measurement for concrete appurtenances shall be by volume in cubic metres for the volume of concrete placed. Alternatively, concrete appurtenances may be a lump sum item.

410.09.01.05 Clay Seal

Measurement for clay seal shall be by volume in cubic metres for the volume of clay placed. Alternatively, clay seal may be a lump sum item.

410.09.02 Plan Quantity Measurement

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

410.10**BASIS OF PAYMENT****410.10.01*****"size, type, class"* Pipe Sewers - Item****Service Connections - Item****Breaking into Maintenance Holes, Catch Basins, Ditch Inlets, Culverts and Sewers - Item****Concrete Appurtenances - Item****Clay Seal - Item**

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

410.10.02**Closed-Circuit Television (CCTV) Inspection**

When a CCTV inspection of pipe sewers is specified in the Contract Documents, payment for CCTV inspection shall be according to OPSS 409.

TABLE 1
Exfiltration Test - Low Pressure Air Testing

NominalPipe Size mm	MinimumTime min:sec	Length for Minimum Time m	Time For Longer Length sec
100	1:53	182	0.623
150	2:50	121	1.140
200	3:47	91	2.493
250	4:43	73	3.893
300	5:40	61	5.606
375	7:05	48	8.761
450	8:30	41	12.615
525	9:55	35	17.171
600	11:20	30	22.425
675	12:45	27	28.382
750	14:10	24	35.040
825	15:35	22	42.397
900	17:00	20	50.450

TABLE 2
Deflection Testing of Pipe Sewers

Nominal Pipe Size mm	Mandrel Contact Length mm
150	100
200	150
250	200
300	250
350	300
375	300
400	300
450	350
500	400
525	450
600	500
675	575
750	675
900	750
1050	900
1200	1050

Appendix 410-A, November 2013
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

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

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Pipe sewer size, type, and class. (410.05.01.01)
- Pipe size. (410.05.01.01)
- Size and grade of steel reinforcement. (410.05.05)
- Alignment and grade tolerances for the pipe installation. (410.07.12.01)
- Placement of clay seals. (410.07.18)
- Requirements to construct concrete appurtenances. (410.07.19)
- Depth of backfill over the pipe sewer. (410.07.20)

The designer should determine if the following are required and, if so, add the requirement in the Contract Documents:

- Use of nitrile gaskets. (410.07.12.01)
- Use of joint seals with corrugated steel pipe products. (410.07.12.04)
- Coring for the installation of subdrain. (410.07.15)
- Coring of a 50 mm diameter weep hole. (410.07.15)
- Field tests. (410.07.16.01)
- Cleaning and flushing prior to inspection and acceptance. (410.07.17)
- Use of steel grating. (410.07.19)
- Payment of concrete appurtenances by volume or lump sum. (410.09.01.04)

The tender item description for pipe sewer should include reference to one or more of the attributes shown, i.e., *size, type, class*. (410.10.01)

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

Appendix 410-A

Related Ontario Provincial Standard Drawings

OPSD 708.010	Catch Basin Connection for Rigid Main Pipe Sewer
OPSD 708.020	Support for Pipe at Catch Basin or Maintenance Hole
OPSD 708.030	Catch Basin Connection for Flexible Main Pipe Sewer
OPSD 802.010	Flexible Pipe Embedment and Backfill Earth Excavation
OPSD 802.013	Flexible Pipe Embedment and Backfill Rock Excavation
OPSD 802.014	Flexible Pipe Embedment in Embankment Original Ground: Earth or Rock
OPSD 802.020	Flexible Pipe Arch Embedment and Backfill Earth Excavation
OPSD 802.023	Flexible Pipe Arch Embedment and Backfill Rock Excavation
OPSD 802.024	Flexible Pipe Arch Embedment in Embankment Original Ground: Earth or Rock
OPSD 802.030	Rigid Pipe Bedding, Cover, and Backfill, Type 1 or 2 Soil - Earth Excavation
OPSD 802.031	Rigid Pipe Bedding, Cover, and Backfill, Type 3 Soil - Earth Excavation
OPSD 802.032	Rigid Pipe Bedding, Cover, and Backfill, Type 4 Soil - Earth Excavation
OPSD 802.033	Rigid Pipe Bedding, Cover, and Backfill, Rock Excavation
OPSD 802.034	Rigid Pipe Bedding and Cover in Embankment, Original Ground: Earth or Rock
OPSD 802.050	Horizontal Elliptical Rigid Pipe Bedding, Cover, and Backfill, Type 1 or 2 Soil - Earth Excavation
OPSD 802.051	Horizontal Elliptical Rigid Pipe Bedding, Cover, and Backfill, Type 3 Soil - Earth Excavation
OPSD 802.052	Horizontal Elliptical Rigid Pipe Bedding, Cover, and Backfill, Type 4 Soil - Earth Excavation
OPSD 802.053	Horizontal Elliptical Rigid Pipe Bedding, Cover, and Backfill, Rock Excavation
OPSD 802.054	Horizontal Elliptical Rigid Pipe Bedding and Cover in Embankment, Original Ground: Earth or Rock
OPSD 802.095	Clay Seal for Pipe Trenches
OPSD 804.030	Concrete Headwall for Pipe Less Than 900 mm Diameter
OPSD 804.040	Concrete Headwall for Sewer or Culvert Pipe
OPSD 804.050	Grating for Concrete Endwall
OPSD 805.010	Height of Fill Table, Round Corrugated Steel Pipe and Structural Plate Corrugated Steel Pipe
OPSD 805.020	Height of Fill Table, Corrugated Steel Pipe Arch and Structural Plate Corrugated Steel Pipe Arch
OPSD 805.030	Height of Fill Table, Spiral Rib Round Pipe
OPSD 805.040	Height of Fill Table, Spiral Rib Pipe Arch
OPSD 806.020	Height of Fill Table, Dual Wall Corrugated Polyethylene Gravity Sewer Pipe, 210 and 320 kPa
OPSD 806.021	Height of Fill Table, Closed Profile Wall Polyethylene Pipe, RSC 160 and 250
OPSD 806.022	Height of Fill Table, Dual Wall Corrugated Polyethylene Gravity Sewer Pipe, RSC 100 and RSC 160
OPSD 806.030	Height of Fill Table, Dual and Triple Wall Corrugated Polypropylene Gravity Sewer Pipe, 320 kPa
OPSD 806.040	Height of Fill Table, Polyvinyl Chloride Gravity Sewer Pipe, 210, 320, and 625 kPa
OPSD 806.060	Height of Fill Table, Polyvinyl Chloride Pressure Pipe for Different Dimension Ratios
OPSD 807.010	Height of Fill Table, Reinforced Concrete Pipe - Confined Trench Class 50-D, 65-D, 100-D, and 140-D
OPSD 807.030	Height of Fill Table, Reinforced Concrete Pipe - Embankment Class 50-D, 65-D, 100-D, and 140-D
OPSD 807.040	Height of Fill Table - Nonreinforced Concrete Pipe Class 3
OPSD 807.050	Height of Fill Table, Horizontal Elliptical Concrete Pipe Class HE-A, HE-I, HE-II, HE-III, and HE-IV
OPSD 1006.010	Sewer Service Connections for Rigid Main Pipe Sewer
OPSD 1006.020	Sewer Service Connections for Flexible Main Pipe Sewer



CONSTRUCTION SPECIFICATION FOR PIPE CULVERT INSTALLATION IN OPEN CUT

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 - Not Used
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 of pipe culverts, pipe culvert end sections, and concrete appurtenances in open cut.

421.01.01 Specification Significance and Use

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

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

421.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

421.02 REFERENCES

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

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

Ontario Provincial Standards Specifications, Construction

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

Ontario Provincial Standard Specifications, Material

OPSS 1004	Aggregates - Miscellaneous
OPSS 1205	Clay Seal
OPSS 1301	Cementing Materials
OPSS 1302	Water
OPSS 1350	Concrete - Materials and Production
OPSS 1440	Steel Reinforcement for Concrete
OPSS 1801	Corrugated Steel Pipe Products
OPSS 1820	Circular Concrete Pipe

OPSS 1840	Non-Pressure Polyethylene Plastic Pipe Products
OPSS 1841	Non-Pressure Polyvinyl Chloride (PVC) Pipe Products
OPSS 1843	Non-Pressure Polypropylene (PP) Plastic Pipe Products
OPSS 1860	Geotextiles

ASTM International

C 507-12 Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe

421.03 DEFINITIONS

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

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

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

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

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

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

Pipe Culvert means an installation designed to provide for the conveyance of surface water, pedestrians, or livestock using preformed or precast pipe sections, circular or non-circular in cross-section, laid end to end using suitable joint materials.

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

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

421.05 MATERIALS

421.05.01 Pipe Materials

421.05.01.01 General

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

Pipe culvert type shall be consistent throughout the length of the pipe culvert as specified in the Contract Documents.

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

421.05.01.02 Concrete Pipe

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

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

421.05.01.03 Corrugated Steel Pipe Products

Corrugated steel pipe products shall be according to OPSS 1801.

421.05.01.04 Polyethylene Pipe Products

Polyethylene pipe products shall be according to OPSS 1840.

421.05.01.05 Polyvinyl Chloride Pipe Products

Polyvinyl chloride pipe products shall be according to OPSS 1841.

421.05.01.06 Polypropylene Plastic Pipe Products

Polypropylene plastic pipe products shall be according to OPSS 1843.

421.05.02 Mortar

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

421.05.03 Clay Seal

Clay seal material shall be according to OPSS 1205.

421.05.04 Concrete

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

421.05.05 Steel Reinforcement

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

421.05.06 Geotextile

Geotextile shall be according to OPSS 1860.

421.07 CONSTRUCTION

421.07.01 Site Preparation

Site preparation shall be according to OPSS 490.

421.07.02 Removals

Removals shall be according to OPSS 510.

421.07.03 Preservation and Protection of Existing Facilities

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

421.07.04 Protection Against Floatation

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

421.07.05 Cold Weather Work

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

421.07.06 Transporting, Unloading, Storing, and Handling Pipe

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

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

421.07.07 Excavation

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

421.07.08 Support Systems

Support systems shall be according to OPSS 404.

421.07.09 Dewatering

Dewatering shall be according to OPSS 517.

421.07.10 Protection Systems

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

421.07.11 Backfilling and Compacting

Backfilling and compacting shall be according to OPSS 401.

421.07.12 Pipe Installation

421.07.12.01 General

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

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

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

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

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

The pipe culvert cut-end finish, end sections, and safety slope end treatments shall be as specified in the Contract Documents.

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

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

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

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

421.07.12.02 Circular Concrete Pipe

All circular concrete pipe joints shall have elastomeric gaskets.

421.07.12.03 Non-Circular Concrete Pipe

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

421.07.12.04 Corrugated Steel Pipe Products

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

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

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

Structural plate pipe culverts may be assembled in the trench or beside the excavation. If the assembled structure has to be moved to its final position, it shall be moved so that no damage or distortion is caused to the structure.

When the structural plate pipe culvert has been placed to the alignment and grade as specified in the Contract Documents, all assembly bolts shall be retightened with a torque wrench to a minimum of:

- a) 200 N·m for 3.5 and 3.0 mm gauge of pipe.
- b) 340 N·m for heavier than 3.5 mm gauge of pipe.

421.07.12.05 Polyethylene Pipe

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

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

421.07.12.06 Polyvinyl Chloride Pipe

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

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

421.07.12.07 Polypropylene Pipe

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

421.07.13 Closed-Circuit Television (CCTV) Inspection

When specified in the Contract Documents, pipe culverts shall be inspected using CCTV equipment. CCTV inspection of pipe culverts shall be according to OPSS 409.

421.07.14 Cleaning and Flushing of Pipe Culverts

When specified in the Contract Documents, pipe culverts shall be cleaned and flushed just prior to inspection and acceptance.

421.07.15 Clay Seals

Clay seals shall be placed as specified in the Contract Documents and compacted to 95% of the Proctor maximum dry density.

421.07.16 Concrete Appurtenances

Concrete appurtenances shall be constructed as specified in the Contract Documents. Concrete in concrete appurtenances shall be placed according to OPSS 904. Steel reinforcement shall be placed according to OPSS 905. Steel grating shall be installed when specified in the Contract Documents.

421.07.17 Site Restoration

Site restoration shall be according to OPSS 492.

421.07.18 Management of Excess Material

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

421.09 MEASUREMENT FOR PAYMENT

421.09.01 Actual Measurement

421.09.01.01 Pipe Culverts Non-Circular Pipe Culverts Pipe Culvert Extensions Non-Circular Pipe Culvert Extensions

Measurement of pipe culverts, non-circular pipe culverts, pipe culvert extensions, and non-circular pipe culvert extensions shall be along the horizontal length of the pipe in metres, from one end of the pipe or pipe end section to the other end of the pipe or the other pipe end section. When the grade of the pipe culvert is 10% or greater, the above measurement shall then be of the slope length.

421.09.01.02 Concrete Appurtenances

Measurement for concrete appurtenances shall be by volume in cubic metres for the volume of concrete placed. Alternatively, concrete appurtenances may be a lump sum item.

421.09.01.03 Clay Seal

Measurement for clay seal shall be by volume in cubic metres for the volume of clay placed. Alternatively, clay seal may be a lump sum item.

421.09.02 Plan Quantity Measurement

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

421.10 BASIS OF PAYMENT

421.10.01 "size, type, class" Pipe Culverts - Item "size, type, class" Non-Circular Pipe Culverts - Item "size, type, class" Pipe Culvert Extensions - Item "size, type, class" Non-Circular Pipe Culvert Extensions - Item Clay Seal - Item Concrete Appurtenances - Item

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

421.10.02 Swamp Excavation

When the Contract requires swamp excavation to place a pipe culvert, payment for the swamp excavation shall be under the tender item covering the swamp excavation for earth embankment construction. No alterations shall be made to the tender item for the pipe culvert so affected.

421.10.03 Closed-Circuit Television (CCTV) Inspection

When a CCTV inspection of pipe culverts is specified in the Contract Documents, payment for the CCTV inspection shall be according to OPSS 409.

Appendix 421-A, November 2013 FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

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

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Pipe culvert size, type, and class. (421.05.01.01)
- Size and grade of steel reinforcement. (421.05.05)
- Alignment and grade tolerances, including camber, for the pipe installation. (421.07.12.01)
- Pipe culvert cut-end finish, end sections, and safety slope end treatments. (421.07.12.01)
- Alignment and grade for the placement of structural plate pipe culvert. (421.07.12.04)
- Placement of clay seals at the inlet side of culverts, as required. (421.07.15)
- Requirements to construct concrete appurtenances. (421.07.16)
- Pipe culvert size, type, class, or other pipe attribute to complete the tender item description. (421.10.01)

The designer should determine if the following are required and, if so, add the requirement in the Contract Documents:

- Use of nitrile gaskets. (421.07.12.01)
- Use of joint seals with corrugated steel pipe products. (421.07.12.04)
- CCTV inspection and any other testing. (421.07.13)
- Cleaning and flushing prior to inspection and acceptance. (421.07.14)
- Use of steel grating. (421.07.16)
- Payment of concrete appurtenances by volume or lump sum. (421.09.01.02)

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

Related Ontario Provincial Standard Drawings

OPSD 800.010	Concrete Pipe Culvert and Sewer Extensions Using Corrugated Steel Pipe
OPSD 800.011	Concrete Rigid Frame Box and Open Culvert Extensions Using Corrugated Steel Pipe
OPSD 801.010	Cut End Finish, Circular Pipe and Pipe-Arch Corrugated Steel Pipe
OPSD 801.020	End Section Details, Corrugated Steel Pipe
OPSD 801.030	Bevel Details for Structural Plate Pipe and Pipe-Arch - Corrugated Steel Pipe

Appendix 421-A

OPSD 801.040	Culvert and Sewer Safety Slope End Treatment, Notes and Tables
OPSD 801.041	Culvert and Sewer Safety Slope End Treatment, Assembly Details
OPSD 801.042	Culvert and Sewer Safety Slope End Treatment, Connection Details
OPSD 801.043	Culvert and Sewer Safety Slope End Treatment, Installation Details
OPSD 802.010	Flexible Pipe Embedment and Backfill, Earth Excavation
OPSD 802.013	Flexible Pipe Embedment and Backfill, Rock Excavation
OPSD 802.014	Flexible Pipe Embedment in Embankment, Original Ground: Earth or Rock
OPSD 802.020	Flexible Pipe Arch Embedment and Backfill, Earth Excavation
OPSD 802.023	Flexible Pipe Arch Embedment and Backfill, Rock Excavation
OPSD 802.024	Flexible Pipe Arch Embedment in Embankment, Original Ground: Earth or Rock
OPSD 802.030	Rigid Pipe Bedding, Cover, and Backfill, Type 1 or 2 Soil - Earth Excavation
OPSD 802.031	Rigid Pipe Bedding, Cover, and Backfill, Type 3 Soil - Earth Excavation
OPSD 802.032	Rigid Pipe Bedding, Cover, and Backfill, Type 4 Soil - Earth Excavation
OPSD 802.033	Rigid Pipe Bedding, Cover, and Backfill, Rock Excavation
OPSD 802.034	Rigid Pipe Bedding and Cover in Embankment, Original Ground: Earth or Rock
OPSD 802.050	Horizontal Elliptical Rigid Pipe Bedding, Cover, and Backfill, Type 1 or 2 Soil - Earth Excavation
OPSD 802.051	Horizontal Elliptical Rigid Pipe Bedding, Cover, and Backfill, Type 3 Soil - Earth Excavation
OPSD 802.052	Horizontal Elliptical Rigid Pipe Bedding, Cover, and Backfill, Type 4 Soil - Earth Excavation
OPSD 802.053	Horizontal Elliptical Rigid Pipe Bedding, Cover, and Backfill, Rock Excavation
OPSD 802.054	Horizontal Elliptical Rigid Pipe Bedding and Cover in Embankment, Original Ground: Earth or Rock
OPSD 802.095	Clay Seal for Pipe Trenches
OPSD 804.030	Concrete Headwall, for Pipe Less Than 900 mm Diameter
OPSD 804.040	Concrete Headwall, for Sewer or Culvert Pipe Outlet
OPSD 804.050	Grating, for Concrete Endwall
OPSD 805.010	Height of Fill Table, Round Corrugated Steel Pipe and Structural Plate Corrugated Steel Pipe
OPSD 805.020	Height of Fill Table, Corrugated Steel Pipe Arch and Structural Plate Corrugated Steel Pipe Arch
OPSD 805.030	Height of Fill Table, Spiral Rib Round Pipe
OPSD 805.040	Height of Fill Table, Spiral Rib Pipe Arch
OPSD 806.020	Height of Fill Table, Dual Wall Corrugated Polyethylene Gravity Sewer Pipe, 210 and 320 kPa
OPSD 806.021	Height of Fill Table, Closed Profile Wall Polyethylene Pipe, RSC 160 and 250
OPSD 806.022	Height of Fill Table, Dual Wall Corrugated Polyethylene Gravity Sewer Pipe RSC 100 and RSC 160
OPSD 806.030	Height of Fill Table, Dual and Triple Wall Corrugated Polypropylene Gravity Sewer Pipe, 320 kPa
OPSD 806.040	Height of Fill Table, Polyvinyl Chloride Gravity Sewer Pipe, 210, 320, and 625 kPa
OPSD 806.060	Height of Fill Table, Polyvinyl Chloride Pressure Pipe for Different Dimension Ratios
OPSD 807.010	Height of Fill Table, Reinforced Concrete Pipe - Confined Trench, Class 50-D, 65-D, 100-D, and 140-D
OPSD 807.030	Height of Fill Table, Reinforced Concrete Pipe - Embankment, Class 50-D, 65-D, 100-D, and 140-D
OPSD 807.040	Height of Fill Table, Non-reinforced Concrete Pipe Class 3
OPSD 807.050	Height of Fill Table, Horizontal Elliptical Concrete Pipe, Class HE-A, HE-I, HE-II, HE-III, and HE-IV



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

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

721.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

721.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 501 Compacting

Ontario Provincial Standard Specifications, Material

OPSS 1350 Concrete - Materials and Production
OPSS 1503 Cable Guide Rail
OPSS 1504 Steel Beam Guide Rail
OPSS 1505 Channel Components for Steel Beam Guide Rail
OPSS 1601 Wood, Preservative Treatment, and Shop Fabrication

Ontario Ministry of Transportation Publications

Ontario Traffic Manual (OTM):
Book 11 - Pavement, Hazard and Delineation Markings

CSA Standards

G164-M92 (R2003) Hot Dip Galvanizing of Irregularly Shaped Articles
O56-10 (R2015) Round Wood Piles

ASTM International

A 36/A 36M-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 and does not include the terminal systems.

**721.09.01.06 Adjust Steel Beam Guide Rail, Wooden Posts
Adjust Steel Beam Guide Rail, Steel Posts
Adjust Steel Beam Guide Rail, Steel Posts with Steel Offset Blocks**

Measurement of adjust steel beam guide rail shall be by length in metres along the centreline of the adjusted system from end to end of each steel beam guide rail installation and includes the end treatments and terminal systems.

721.09.01.07 Steel Beam Guide Rail Structure Connections

For measurement purposes, a count shall be made of the number of steel beam guide rail structure connections installed.

721.09.02 Plan Quantity Measurement

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

721.10 BASIS OF PAYMENT

**721.10.01 Cable Guide Rail - Item
Adjust Cable Guide Rail - Item
Cable Guide Rail Post Replacement - Item
Anchor Blocks - Item
Single Rail Steel Beam Guide Rail - Item
Single Rail Steel Beam Guide Rail with Channel - Item
Double Rail Steel Beam Guide Rail - Item
Adjust Steel Beam Guide Rail, Wooden Posts - Item
Adjust Steel Beam Guide Rail, Steel Posts - Item
Adjust Steel Beam Guide Rail, Steel Posts with Steel Offset Blocks - Item
Steel Beam Guide Rail Structure Connections – Item**

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

The designer should specify the following in the Contract Documents:

- Guide rail system locations. (721.07.01)
- Cable guide rail to be adjusted. (721.07.02.04)
- Cable guide rail post to be replaced. (721.07.02.05)
- Steel beam guide rail to be adjusted. (721.07.03.04)

Leaving end treatment should be used on divided highways and ramps, when the leaving end of the installation is located beyond the clear zone for opposing traffic.

Height adjustments for steel beam guide rail with wooden post shall be a minimum of 50 mm.

Cable Guide Rail Adjustment:

Mounting height tolerances for cable guide rail (CGR) are provided in the MTO Roadside Safety Manual. The purpose of the Adjust Cable Guide Rail item is to allow for the adjustment of the mounting height of an existing CGR installation. Generally, adjustment is necessary at locations where the pavement rehabilitation strategy will raise the existing ground elevation adjacent to an existing guide rail installation. An evaluation of existing guide rail will provide the designer with an inventory of the type of existing guide rail systems as well as the existing mounting height.

When adjusting CGR systems, the posts remain in their current location and the cables are reinstalled at the new mounting height. If the CGR was installed according to OPSD 913.130, there should be approximately 150 mm of space available for adjustment assuming that this is the first adjustment. Cables are not to be installed within 200 mm of the top of the posts. This ensures that the cables do not interfere with the reflectorized strip.

The Adjust Cable Guide Rail tender item also includes the removal and replacement of cable clamps and nails, the installation of one new turnbuckle per cable between anchor blocks, and the installation of new reflectorized strips.

When the evaluation of the existing CGR indicates that the posts are in unsound condition, out of plumb, or cannot meet the mounting height tolerance, it may be necessary to replace some or all of the posts. The Cable Guide Rail Post Replacement tender item can be used to replace existing cable guide rail posts when the remainder of the components (i.e., cables and anchor blocks) are in satisfactory condition.

Appendix 721-A

Steel Beam Guide Rail Adjustment:

Mounting height tolerances for steel beam guide rail (SBGR) are specified in OPSS 721. There are three tender items available for adjustment of SBGR. The purpose of these items is to allow for the adjustment of the mounting height of an existing SBGR installation on wooden or steel posts. Generally, adjustment is necessary at locations where the pavement rehabilitation strategy will raise the existing ground elevation adjacent to an existing guide rail installation. An evaluation of the existing guide rail will provide the designer with an inventory of the type of existing guide rail systems as well as existing mounting height. Existing SBGR installations may consist of the following configurations:

a) Wooden posts with wooden offset blocks:

Although still installed today, these systems were used primarily in the years prior to implementation of SBGR on steel posts in 1995. When adjusting these systems, the posts remain in their current location, but the offset block and rail (and channel, where necessary) are reinstalled at the new mounting height. If the guide rail was installed according to OPSD 912.140, there should be approximately 150 mm of space available for adjustment assuming this is the first adjustment. The evaluation of existing guide rail should determine whether the existing installation can accommodate the proposed change in height.

b) Steel post with steel offset blocks:

Steel post systems have been the most common since they were first implemented in 1995 mainly due to their relative ease of handling and installation. Steel offset blocks were used exclusively with steel post systems from 1995 through 2002 when the standard was revised to specify routed wooden blocks. When they are adjusted, existing steel post systems with steel offset blocks will be retrofitted with routed wooden or plastic offset blocks. This requires the punching of a new hole to accommodate the wooden or plastic offset block.

c) Steel posts with wooden or plastic offset blocks:

From 2003 through the early 2008, steel post systems were installed exclusively with routed wooden offset blocks. In 2008, plastic offset blocks were implemented as an alternative to the routed wooden offset blocks. Since that time, steel post systems with plastic offset blocks have been the most common steel beam system.

Selection of the appropriate tender item for each installation will ensure that the Contractor will address the unique adjustment requirements of each system configuration.

Tender items for adjustment include the removal and replacement of existing hardware including bolts, washers, and nuts as well as the installation of new reflectors. For SBGR with steel offset blocks, replacement of steel offset blocks with plastic or wooden offset blocks is included.

Existing end terminals and treatments should be reviewed when SBGR is being considered for adjustment.

Existing end terminals may consist of eccentric loader terminal (ELT) systems, extruder terminal (ET) systems, or sequential kinking terminal (SKT) systems:

a) ELT Systems:

- Consider replacement of ELT installations that are greater than or equal to 5 years in age with a new steel beam energy attenuating terminal (SBEAT) system. If the ELT system is located on a horizontal curve with a radius of less than 190m, a new ELT should be installed.

Appendix 721-A

b) SBEATs:

- Existing ET and SKT systems consist of several different variations on wooden and steel posts.
- Consider replacement of ET and SKT system installations on wooden posts with a new SBEAT System.
- ET and SKT systems on steel posts that are in good condition may be adjusted.

Existing leaving end treatments consisting of buried leaving end treatments (formerly OPSD 912.233) or upright fishtail ends:

- Buried leaving end treatments are a challenge to adjust and could be replaced with a standard leaving end treatment according to OPSD 912.235. This would require the removal of 16 m of existing SBGR and subsequent installation of 4 m of new SBGR according to OPSD 912.235.
- Existing upright fishtail type end treatments typically have been installed based on the extension requirements for unanchored guide rail in accordance with Table 3.4.2 in the MTO Roadside Safety Manual. When replacing an upright fishtail end treatment with a standard leaving end treatment, ensure that after removal of the unanchored end beyond the hazard that the 4 m of new SBGR in accordance with OPSD 912.235 extends beyond the hazard by 4 m.
- Where an existing buried end treatment or upright fishtail end treatment is on the leaving end of a SBGR installation located on an undivided highway or at a location on a divided highway where the end of the SBGR is located within the clear zone for opposing traffic, the treatment should be considered for replacement with an end terminal.

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

Related Ontario Provincial Standard Drawings

OPSD 912.130	Guide Rail System, Steel Beam, Steel Post With Offset Block Assembly, Installation - Single Rail
OPSD 912.140	Guide Rail System, Steel Beam, Wooden Post Assembly, Installation - Single Rail
OPSD 912.141	Guide Rail System, Steel Beam, Wooden Post Assembly, Installation - Double Rail
OPSD 912.234	Guide Rail System, Steel Beam, End Treatment, Installation - Leaving End Collector Median
OPSD 912.235	Guide Rail System, Steel Beam, Leaving End Treatment, Installation
OPSD 912.240	Guide Rail System, Steel Beam, Treatment at Culverts With Minimal Cover Installation - Single Rail
OPSD 912.380	Guide Rail System, Steel Beam, Permanent Transition Installation, Channel Termination, Median
OPSD 912.430	Guide Rail System, Steel Beam, Structure Connection
OPSD 912.480	Guide Rail System, Steel Beam, Permanent Connection Installation, Single Steel Beam to Concrete Barrier
OPSD 912.481	Guide Rail System, Steel Beam, Permanent Connection Installation, Double Steel Beam to Concrete Barrier
OPSD 912.530	Guide Rail System, Steel Beam, Structure Approach Treatment, Installation - Rural Highway
OPSD 912.531	Guide Rail System, Steel Beam, Installation - Entrances and Intersecting Roadways
OPSD 912.532	Guide Rail System, Steel Beam, Barricade, Installation
OPSD 913.130	Guide Rail System, Cable, Installation - Shoulder



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

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

723.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

723.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 314	Untreated Granular Subbase, Base, Surface Shoulder, and Stockpiling
OPSS 510	Removal
OPSS 705	Flexible Delineator Posts
OPSS 740	Concrete Barriers
OPSS 904	Concrete Structures

Ontario Provincial Standard Specifications, Material

OPSS 1350	Concrete - Materials and Production
OPSS 1440	Steel Reinforcement for Concrete

Ontario Ministry of Transportation Publications

Ontario Traffic Manual (OTM):
Book 6 - Warning Signs

ASTM International

A 123/A 123M-13	Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
A 325-14	Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
A 780/A 780M-09	Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
D 4956-13	Retroreflective Sheeting for Traffic Control

723.03 DEFINITIONS

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

Dual Duty means a new high exposure energy attenuator that is supplied and installed in a temporary configuration during construction, temporarily relocated as required, and then relocated to its permanent location prior to the end of the Work.

High Exposure means an energy attenuator that is installed in a location where the risk of impact is expected to be high such as in gore areas at exit ramps and express - collector transfers.

Reduced Exposure means a temporary energy attenuator that is installed in a location where the risk of impact is expected to be low. These energy attenuators should be specified in a location where they will be required for short duration of less than four months, are frequently relocated, and where they are not required during seasonal shutdown.

723.04 DESIGN AND SUBMISSION REQUIREMENTS

723.04.01 Design Requirements

The energy attenuator manufacturer shall complete the design of any non-standard details (e.g., a connection or transition to a rigid object other than a concrete barrier or temporary concrete barrier) at locations specified in the Contract Documents.

723.04.02 Submission Requirements

One copy of the manufacturer's installation instructions and Working Drawings shall be submitted to the Contract Administrator.

Installation of the energy attenuator shall not commence until the Contract Administrator has received the copy of the instructions and Working Drawings.

723.04.02.01 Submission Requirements for Non-Standard Details

Three copies of Working Drawings, prepared by the manufacturer, for any non-standard details shall be submitted to the Contract Administrator prior to the commencement of construction. The Working Drawings shall show full details of the materials and installation procedures. An Engineer's seal and signature shall be affixed on the Working Drawings verifying that the drawings are consistent with the Contract Documents. The submission of Working Drawings shall be accompanied by 3 copies of a letter that has been signed by the manufacturer, on company letterhead, summarizing the details of the proposed design.

Installation of the energy attenuator shall not commence until the Contract Administrator has received and accepted the copy of the letters and Working Drawings.

723.05 MATERIALS

723.05.01 General

All supplied system components shall be according to the manufacturer's specifications.

723.05.02 Energy Attenuator Systems

The names of systems acceptable for the Energy Attenuator - Permanent items are shown in Table 1.

The names of systems acceptable for the Energy Attenuator - Temporary items are shown in Table 2.

The Contractor shall have the option of supplying and installing any of these approved systems shown for the appropriate tender item.

When a specific energy attenuator system is specified in the Contract Documents, there shall not be an option of substitution for the energy attenuator system.

723.05.03 Concrete

Concrete for pads and anchor blocks shall be according to OPSS 1350 with a nominal minimum 28-Day compressive strength of 30 MPa.

723.05.04 Steel Reinforcement

Steel reinforcement shall be according to OPSS 1440.

723.05.05 Anchor Bolts

Anchor bolts shall be supplied and installed according to energy attenuator manufacturer recommendations.

723.05.06 Bolts for Connection of BB-BEAT System to Concrete Barrier

Bolts used to connect the BB-BEAT system to the concrete barrier shall be according to ASTM A 325 and shall be hot dip galvanized according to ASTM A 123.

723.05.07 U Channel Posts

Posts shall be 2.44 m long perforated steel U channel with 11 mm diameter holes spaced on 50 mm centres, minimum weight of 4.46 kg/m, and hot dip galvanized according to ASTM A 123.

723.05.08 Flexible Delineator Posts

Flexible delineator posts shall be according to OPSS 705. The post colour shall be orange.

723.05.09 Reflective Sheeting

Flexible delineator posts shall be outfitted with high intensity retroreflective sheeting according to ASTM D 4956, Type IV; white colour; and to the dimensions specified in the Contract Documents.

723.05.10 Reuse of Materials

Notwithstanding subsection GC 5.02, Quality of Material, paragraph 01 of the General Conditions of Contract, the reuse of materials is permitted for temporary energy attenuator installations and relocations, provided the components have not been damaged to affect the safety performance of the system.

723.07 CONSTRUCTION

723.07.01 General

Permanent and temporary energy attenuators shall be installed according to manufacturer's instructions at locations specified in the Contract Documents. A reference for energy attenuator Contract Drawing Notation is shown in Table 3.

Energy attenuators shall not be placed on surfaces with a crossfall greater than 6%.

723.07.02 Permanent Installation

723.07.02.01 New Concrete Pads

Levelling and site preparation required for the existing granular base shall be performed prior to placing the concrete pad. The concrete pad shall be constructed as specified in the Contract Documents. Concrete shall be placed, cured, and finished according to OPSS 904.

The granular base below new concrete pads shall be a minimum depth of 150 mm of existing or new Granular A and shall be according to OPSS 314.

723.07.02.02 Existing Concrete Surfaces and Pads

When specified in the Contract Documents, existing 200 mm thick concrete surfaces, pads, or precast pads may be used to support the energy attenuator.

723.07.02.03 Connection of BB-BEAT and QuadTrend Systems to Concrete Barrier

When the BB-BEAT or QuadTrend system is connected to new concrete barrier, the adjacent 4.0 m of concrete barrier shall be according to OPSS 740 and the Contract Documents.

When the BB-BEAT or QuadTrend system is connected to existing concrete barrier, the adjacent 4.0 m of existing concrete barrier shall be removed according to OPSS 510 and a new 4.0 m section of concrete barrier shall be installed according to OPSS 740 and the Contract Documents.

723.07.02.04 Rear Cable Anchor Blocks for QuadTrend Systems

Rear cable anchor blocks shall be as specified in the Contract Documents. In both earth and rock fills, rear cable anchor blocks shall be placed on slopes 3H:1V or flatter. The cable supplied with the unit shall be used to determine the proper location of the rear cable anchor block.

In porous or crumbly soils, forms for cast-in-place anchor blocks shall be used to prevent contamination of the concrete. Forms may be left in place or removed.

The top of the concrete block shall be flush with the embankment slope and the rear cable anchor assembly shall not protrude more than 100 mm above ground.

723.07.02.05 Damage to Galvanizing

Precautions shall be taken to protect galvanizing against damage. Minor abrasions shall be repaired according to ASTM A 780. Components with major abrasions shall be replaced.

The method of repair for any damage shall be approved by the Contract Administrator prior to the commencement of such work.

723.07.02.06 Posts for BB-BEAT Systems

All posts shall be set to the alignment specified in the Contract Documents, regardless of the material encountered. Permissible tolerance for plumb shall be 20 mm maximum over the post length above the ground. The driving of posts shall be accomplished with methods and equipment that leave the posts free of distortion, burring, and any other damage.

All lower end posts shall be installed so that not more than 100 mm is exposed above finished grade.

723.07.03 Temporary Installation

723.07.03.01 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
Smart System - Permanent
Quadguard System - Permanent
Quadguard Wide System - Permanent
Quadguard Extra Wide System - Permanent
Quadguard Super Wide System - Permanent
TRACC System - Permanent
TAU-II System - Permanent
TAU-II Wide System - Permanent**

TAU-II Extra Wide System - Permanent
QuadTrend System - Permanent
Box Beam Bursting Energy Absorbing Terminal System - Permanent

For measurement purposes, a count shall be made of the number of complete energy attenuator systems installed.

723.09.01.02 **Energy Attenuator - Temporary, Narrow**
Energy Attenuator - Temporary, Wide
Energy Attenuator - Temporary, Extra Wide
Energy Attenuator - Temporary, Super Wide
Energy Attenuator - Temporary, Reduced Exposure
Energy Attenuator - Temporary, Dual Duty
Smart System - Temporary
Quadguard System - Temporary
Quadguard Wide System - Temporary
Quadguard Extra Wide System - Temporary
Quadguard Super Wide System - Temporary
TAU-II System - Temporary
TAU-II Wide System - Temporary
TAU-II Extra Wide System - Temporary
TRACC System - Temporary
ABSORB 350 System - Temporary
ACZ-350 System - Temporary

For measurement purposes, a count shall be made of the number of complete energy attenuator systems installed and removed, up to the maximum number of systems required to be in place at any one time during the Contract.

723.09.01.03 **Energy Attenuator - Relocation, Narrow**
Energy Attenuator - Relocation, Wide
Energy Attenuator - Relocation, Extra Wide
Energy Attenuator - Relocation, Super Wide
Energy Attenuator - Relocation, Reduced Exposure
Energy Attenuator - Relocation, Dual Duty
Smart System - Relocation
Quadguard System - Relocation
Quadguard Wide System - Relocation
Quadguard Extra Wide System - Relocation
Quadguard Super Wide System - Relocation
TAU-II System - Relocation
TAU-II Wide System - Relocation
TAU-II Extra Wide System - Relocation
TRACC System - Relocation
ABSORB 350 System - Relocation
ACZ-350 System - Relocation

For measurement purposes, a count shall be made of the number of complete energy attenuator systems relocated. Systems that are temporarily surplus and are required for future stages shall be paid for as one relocation for the combined moves into and out of storage, including any off-site storage required due to on-site restrictions.

723.09.02 Plan Quantity Measurement

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

723.10 BASIS OF PAYMENT

- 723.10.01** Energy Attenuator - Permanent, Narrow - Item
- Energy Attenuator - Permanent, Wide - Item
- Energy Attenuator - Permanent, Extra Wide – Item
- Energy Attenuator - Permanent, Super Wide – Item
- Energy Attenuator - Permanent, High Exposure - Item
- Energy Attenuator - Permanent, Single-Sided - Item
- Smart System - Permanent - Item
- Quadguard System - Permanent - Item
- Quadguard Wide System - Permanent - Item
- Quadguard Extra Wide System - Permanent - Item
- Quadguard Super Wide System - Permanent - Item
- TRACC System - Permanent - Item
- TAU-II System - Permanent - Item
- TAU-II Wide System - Permanent - Item
- TAU-II Extra Wide System - Permanent - Item
- QuadTrend System - Permanent - Item
- Box Beam Bursting Energy Absorbing Terminal System - Permanent - Item
- Energy Attenuator - Temporary, Narrow - Item
- Energy Attenuator - Temporary, Wide - Item
- Energy Attenuator - Temporary, Extra Wide - Item
- Energy Attenuator - Temporary, Super Wide - Item
- Energy Attenuator - Temporary, Reduced Exposure - Item
- Energy Attenuator - Temporary, Dual Duty - Item
- Smart System - Temporary - Item
- Quadguard System - Temporary - Item
- Quadguard Wide System - Temporary - Item
- Quadguard Extra Wide System - Temporary - Item
- Quadguard Super Wide System - Temporary - Item
- TAU-II System - Temporary - Item
- TAU-II Wide System - Temporary - Item
- TAU-II Extra Wide System - Temporary - Item
- TRACC System - Temporary - Item
- ABSORB 350 System - Temporary - Item
- ACZ-350 System - Temporary - Item
- Energy Attenuator - Relocation, Narrow - Item
- Energy Attenuator - Relocation, Wide - Item
- Energy Attenuator - Relocation, Extra Wide - Item
- Energy Attenuator - Relocation, Super Wide - Item
- Energy Attenuator - Relocation, Reduced Exposure - Item
- Energy Attenuator - Relocation, Dual Duty - Item
- Smart System - Relocation - Item
- Quadguard System - Relocation - Item
- Quadguard Wide System - Relocation - Item
- Quadguard Extra Wide System - Relocation - Item
- Quadguard Super Wide System - Relocation - Item
- TAU-II System - Relocation - Item
- TAU-II Wide System - Relocation - Item
- TAU-II Extra Wide System - Relocation - Item

TRACC System - Relocation - Item
ABSORB 350 System - Relocation - Item
ACZ-350 System - Relocation - Item

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

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

Costs associated with any required removals and replacement or repairs of defective work and materials shall be the Contractor's responsibility at no additional cost to the Owner.

TABLE 1
Energy Attenuator, Permanent

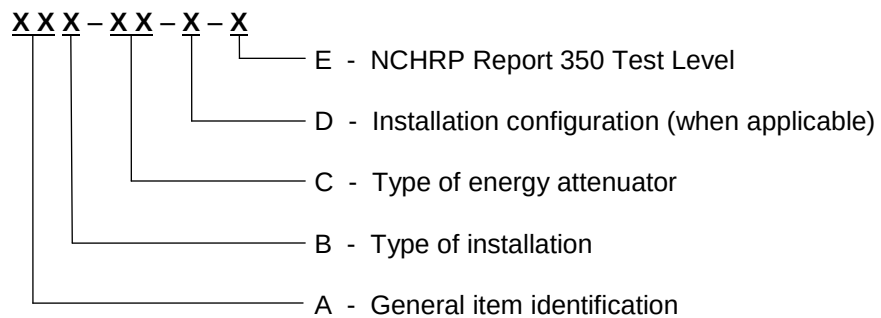
Energy Attenuator	NCHRP Report 350 Test Level		Permanent Installation					
	TL-2	TL-3	Narrow (NA)	Wide (WI)	Extra Wide (EW)	Super Wide (SW)	High Exposure (HE)	Single- Sided (SS)
TAU-II System	Yes	Yes	Yes	No	No	No	No	No
TAU-II Wide System	Yes	Yes	No	Yes	No	No	No	No
TAU-II Extra Wide System	Yes	Yes	No	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

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

The designer should specify the following in the Contract Documents:

- Energy attenuator system locations using the notation shown in Table 3. (723.07.01)
- Relocation of energy attenuators using the notation shown in Table 3. (723.07.01 and 723.07.03.06)

The designer should specify whether each system is TL-2 or TL-3 configuration. TL-2 configurations are required for low-speed installations with posted speeds of less than 70 km/h. TL-3 configurations are required for high-speed installations with posted speeds of 70 km/h and greater. Single-sided systems are only available in a TL-3 configuration. (723.07.01)

A permanent energy attenuator installation should include a new concrete pad (723.07.02.01). If an existing concrete surface or pad can be used to support the system, it should be specified in the Contract Documents (723.07.02.02). The designer should confirm that the existing concrete surface or pad is in good condition and will provide a smooth operating surface for the system.

The designer should confirm that one of the following foundation options is available for each temporary energy attenuator installation (723.07.03):

- a) Existing concrete surface:
 - minimum 200 mm deep, 28 MPa minimum compressive strength
- b) Asphalt over compacted granular:
 - minimum 150 mm asphalt over 150 mm minimum compacted granular
 - the asphalt must extend a minimum of 500 mm beyond the anchor bolts
- c) Asphalt over concrete
 - minimum 75 mm asphalt over 75 mm minimum concrete, 28 MPa minimum compressive strength

The designer should confirm that the existing surface is in good condition and will provide a smooth operating surface for the system.

When a single-sided system is connected to existing concrete barrier as specified in the Contract Documents, the designer should include payment in the Contract Documents for the removal of the 4.0 m section of existing concrete barrier and placement of a new 4.0 m section adjacent to each system. (723.07.02.03)

Single-sided systems shall be installed with grading according to OPSS 202.033. Single-sided systems should not be installed in a location where backside hits towards the concrete barrier are possible (e.g., in gore areas), or in a narrow median where backside opposite direction hits are possible. The area behind and beyond the end terminal should be traversable and free of fixed objects. The minimum recommended rectangular area should be 6 m wide, measured behind and perpendicular to the back of the rail, by 22 m long, measured from the front face of the system and parallel to the system. (723.07.02.03)

Appendix 723-A

When the reduced exposure tender item is selected, the designer should confirm that the following requirements for water filled energy attenuator systems are satisfied (723.07.03.04):

- a) Water filled energy attenuator systems shall be installed at an offset of not less than 2.0 m from the edge of the travelled way.
- b) When installed adjacent to an existing guide rail system, the clearance shall be less than or equal to 0.3 m or greater than or equal to 3.0 m. Otherwise, the area behind and beyond the water filled energy attenuator system shall be traversable and free of fixed objects. The minimum recommended rectangular area shall be 6 m wide, measured behind and perpendicular to the back of the system, by 22 m long, measured from the front face of the system and parallel to the system.
- c) At a minimum, the first 16 m of temporary concrete barrier shall be placed tangential to the water filled energy attenuator system.

When the item for payment is Energy Attenuator, the designer should not include any drawings for specific energy attenuators in the Contract Documents.

Wherever possible, the designer should eliminate the use of curb with gutter in advance of and along the length of end treatments and crash cushions. See MTO Roadside Safety Manual for additional information.

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

Related Ontario Provincial Standard Drawings

OPSD 202.033	Roadway Widening, Single Sided Energy Attenuating Terminals, Approach End
OPSD 922.131	Energy Attenuator, Crash Cushion, QuadTrend System, Installation - Concrete Barrier
OPSD 922.133	Energy Attenuator, Crash Cushion, QuadTrend System, Installation - Concrete Pad and Rear Cable Anchor Block
OPSD 923.001	Energy Attenuator, Crash Cushion, Narrow Systems, Component - Reinforced Concrete Pad
OPSD 923.002	Energy Attenuator, Crash Cushion, Component - Anchor Assembly
OPSD 923.004	Energy Attenuator, Crash Cushion, Wide Systems, Component - Reinforced Concrete Pad
OPSD 923.005	Energy Attenuator, Crash Cushion, Extra Wide Systems, Component - Reinforced Concrete Pad
OPSD 923.006	Energy Attenuator, Crash Cushion, Quadguard Super Wide System, Component - Reinforced Concrete Pad
OPSD 923.180	Energy Attenuator, Crash Cushion, Quadguard System, Installation - Temporary, Unidirectional
OPSD 923.181	Energy Attenuator, Crash Cushion, Quadguard System, Installation - Temporary, Bidirectional
OPSD 923.182	Energy Attenuator, Crash Cushion, Quadguard System, Installation - Permanent, Unidirectional
OPSD 923.183	Energy Attenuator, Crash Cushion, Quadguard System, Installation - Permanent, Bidirectional
OPSD 923.184	Energy Attenuator, Crash Cushion, Quadguard Wide System, Installation - Temporary, Unidirectional
OPSD 923.185	Energy Attenuator, Crash Cushion, Quadguard Wide System, Installation - Temporary, Bidirectional

Appendix 723-A

OPSD 923.186	Energy Attenuator, Crash Cushion, Quadguard Wide System, Installation - Permanent, Unidirectional
OPSD 923.187	Energy Attenuator, Crash Cushion, Quadguard Wide System, Installation - Permanent, Bidirectional
OPSD 923.188	Energy Attenuator, Crash Cushion, Quadguard Extra Wide System, Installation - Temporary, Unidirectional
OPSD 923.189	Energy Attenuator, Crash Cushion, Quadguard Extra Wide System, Installation - Temporary, Bidirectional
OPSD 923.190	Energy Attenuator, Crash Cushion, Quadguard Extra Wide System, Installation - Permanent, Unidirectional
OPSD 923.191	Energy Attenuator, Crash Cushion, Quadguard Extra Wide System, Installation - Permanent, Bidirectional
OPSD 923.192	Energy Attenuator, Crash Cushion, Quadguard Super Wide System, Installation - Temporary, Unidirectional
OPSD 923.193	Energy Attenuator, Crash Cushion, Quadguard Super Wide System, Installation - Temporary, Bidirectional
OPSD 923.194	Energy Attenuator, Crash Cushion, Quadguard Super Wide System, Installation - Permanent, Unidirectional
OPSD 923.195	Energy Attenuator, Crash Cushion, Quadguard Super Wide System, Installation - Permanent, Bidirectional
OPSD 923.280	Energy Attenuator, Crash Cushion, TRACC System, Installation - Temporary, Unidirectional
OPSD 923.281	Energy Attenuator, Crash Cushion, TRACC System, Installation - Temporary, Bidirectional
OPSD 923.282	Energy Attenuator, Crash Cushion, TRACC System, Installation - Permanent, Unidirectional
OPSD 923.283	Energy Attenuator, Crash Cushion, TRACC System, Installation - Permanent, Bidirectional
OPSD 923.380	Energy Attenuator, Crash Cushion, TAU-II System, Installation - Temporary, Unidirectional
OPSD 923.381	Energy Attenuator, Crash Cushion, TAU-II System, Installation - Temporary, Bidirectional
OPSD 923.382	Energy Attenuator, Crash Cushion, TAU-II System, Installation - Permanent, Unidirectional
OPSD 923.383	Energy Attenuator, Crash Cushion, TAU-II System, Installation - Permanent, Bidirectional
OPSD 923.384	Energy Attenuator, Crash Cushion, TAU-II Wide System, Installation - Temporary, Unidirectional
OPSD 923.385	Energy Attenuator, Crash Cushion, TAU-II Wide System, Installation - Temporary, Bidirectional
OPSD 923.386	Energy Attenuator, Crash Cushion, TAU-II Wide System, Installation - Permanent, Unidirectional
OPSD 923.387	Energy Attenuator, Crash Cushion, TAU-II Wide System, Installation - Permanent, Bidirectional
OPSD 923.388	Energy Attenuator, Crash Cushion, TAU-II Extra Wide System - TL-2, Installation - Temporary, Unidirectional
OPSD 923.389	Energy Attenuator, Crash Cushion, TAU-II Extra Wide System - TL-2, Installation - Temporary, Bidirectional
OPSD 923.390	Energy Attenuator, Crash Cushion, TAU-II Extra Wide System - TL-3, Installation - Temporary, Unidirectional
OPSD 923.391	Energy Attenuator, Crash Cushion, TAU-II Extra Wide System - TL-3, Installation - Temporary, Bidirectional
OPSD 923.392	Energy Attenuator, Crash Cushion, TAU-II Extra Wide System - TL-2, Installation - Permanent, Unidirectional

Appendix 723-A

OPSD 923.393	Energy Attenuator, Crash Cushion, TAU-II Extra Wide System - TL-2, Installation - Permanent, Bidirectional
OPSD 923.394	Energy Attenuator, Crash Cushion, TAU-II Extra Wide System - TL-3, Installation - Permanent, Unidirectional
OPSD 923.395	Energy Attenuator, Crash Cushion, TAU-II Extra Wide System - TL-3, Installation - Permanent, Bidirectional
OPSD 923.480	Energy Attenuator, Crash Cushion, Smart System, Installation - Temporary, Unidirectional
OPSD 923.481	Energy Attenuator, Crash Cushion, Smart System, Installation - Temporary, Bidirectional
OPSD 923.482	Energy Attenuator, Crash Cushion, Smart System, Installation - Permanent, Unidirectional
OPSD 923.483	Energy Attenuator, Crash Cushion, Smart System, Installation - Permanent, Bidirectional
OPSD 923.530	Energy Attenuator, Crash Cushion, Box Beam Bursting Energy Absorbing Terminal, Installation - Layout
OPSD 923.531	Energy Attenuator, Crash Cushion, Box Beam Bursting Energy Absorbing Terminal, Installation - Impact Head and Post
OPSD 924.131	Energy Attenuator, Crash Cushion, ABSORB 350 System, Installation - Temporary Concrete Barrier
OPSD 924.135	Energy Attenuator, Crash Cushion, ACZ-350 System, Installation - Temporary Concrete Barrier
OPSD 984.203	Energy Attenuator, Crash Cushion, Delineation, Installation - Temporary
OPSD 984.204	Energy Attenuator, Crash Cushion, Delineation, Installation - Permanent

