



**CONSTRUCTION SPECIFICATION FOR THE
REHABILITATION OF GRAVITY PIPE AND
BOX CULVERT BY PIPE INSERT LINER**

TABLE OF CONTENTS

466.01	SCOPE
466.02	REFERENCES
466.03	DEFINITIONS
466.04	DESIGN AND SUBMISSION REQUIREMENTS
466.05	MATERIALS
466.06	EQUIPMENT - Not Used
466.07	CONSTRUCTION
466.08	QUALITY ASSURANCE
466.09	MEASUREMENT FOR PAYMENT
466.10	BASIS OF PAYMENT
466.01	SCOPE

This specification covers the requirements for the rehabilitation of existing pipe culvert, stormsewer, and box culvert using pipe insert liner trenchless technology technique.

466.02 REFERENCES

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

Ontario Provincial Standard Specifications, Construction

OPSS 409	Closed-Circuit Television (CCTV) Inspection of Pipelines
OPSS 411	Construction Specification for the Cleaning and Flushing of Culverts, Pipe Sewers, Catchbasins, Maintenance Holes, Ditch Inlets, and Oil-Grit Separators
OPSS 490	Construction Specification for Site Preparation
OPSS 491	Preservation, Protection, and Reconstruction of Existing Facilities
OPSS 510	Construction Specification for Removal
OPSS 517	Construction Specification for Dewatering
OPSS 539	Construction Specification for Temporary Protection Systems
OPSS 919	Formwork and Falsework

Ontario Provincial Standard Specifications, Material

OPSS 1301	Material Specification for Cementing Materials
OPSS 1801	Material Specification for Corrugated Steel Pipe (CSP) Products
OPSS 1802	Material Specification for Smooth Walled Steel Pipe
OPSS 1840	Material Specification for Non-Pressure Polyethylene (PE) Plastic Pipe Products
OPSS 1841	Material Specification for Non-Pressure Polyvinyl Chloride (PVC) Pipe Products
OPSS 1843	Material Specification for Non-Pressure Polypropylene (PP) Plastic Pipe Products

Ontario Ministry of Transportation Publications

MTO Forms:

PH-CC-701 Request to Proceed

PH-CC-702 Notice to Proceed

ASTM International

A252/A252M-19	Specification for Welded and Seamless Steel Pipe Piles
C33/C33M-18	Specification for Concrete Aggregates
C39/C39M-21	Test Method for Compressive Strength of Cylindrical Concrete Specimens
D2657-05(2015)	Practice for Heat Fusion of Joining Polyolefin, Pipe and Fittings
D3350-21	Specification for Polyethylene (PE) Plastics Pipe and Fitting Materials
D6910/D6910M-19	Test Method for Marsh Funnel Viscosity of Construction Slurries
F714-22	Specification for Polyethylene (PE) Plastic Pipe (DR-PR) based on Outside Diameter
F894-19	Specification for Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe

466.03 DEFINITIONS

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

Annular Space means the space between the new inserted pipe and the host pipe or box culvert.

Box Culvert means existing culvert constructed of precast reinforced concrete box units rectangular in cross-section.

Bulkheads mean seals constructed at the inlet and outlet of the host pipe or box culvert to seal the annular space and contain the grout.

Design Engineer means the Engineer retained by the Contractor who produces the design and Working Drawings and other engineering documents required of the Contractor.

Host Pipe means existing original pipe culvert or sewer to be internally rehabilitated by Pipe Insert Liner.

Liner means a material which acts as a lining inside the host pipe or box culvert.

Non-Destructive Testing means a testing and analysis technique used by the industry to evaluate the properties of a material, component, structure or system without damaging or destroying the object being tested.

Pipe Insert Liner means insertion of a new solid pipe of smaller diameter by pulling or pushing it into the host pipe or box culvert and grouting the annular space. The inserted pipe used may be continuous or a string of discrete pipes.

466.04 DESIGN AND SUBMISSION REQUIREMENTS

466.04.01 Design Requirements

466.04.01.01**Working Drawings**

Three copies of written procedures and Working Drawings showing the design calculations and entire work plan for the pipe insert liner rehabilitation of the host pipe or box culvert shall be submitted to the Contract Administrator a minimum of 2 weeks or as per the Contract Documents, prior to commencement of the pipe insert liner installation. Prior to making a submission, the seal and signature of a design Engineer shall be affixed on the written procedures and Working Drawings verifying the drawings are consistent with the Contract Documents.

The written procedures and Working Drawings shall include the following:

- a) The Working Area layout;
- b) A work plan outlining the materials, procedures, methods and schedule to be used to execute the work;
- c) A traffic control plan;
- d) A work plan including all materials and methods for any repairs necessary to the host pipe or existing culvert prior to the pipe insert liner application;
- e) A safety plan including the company safety manual and emergency procedures;
- f) Material mixture and installation procedures for repairs and/or filling voids;
- g) Details of the bulkheads to be used at the ends of the pipe insert liner;
- h) Details of the grouting procedures, including measures to be taken to ensure that no voids are left in the annular space;
- i) Methods for tracking the actual volume of grout used in the annular space;
- j) Calculations for the theoretical volume of the grout required to fill the annular space based on the pipe insert liner specifications and the field measured dimensions of the interior of the host pipe or box culvert;
- k) Determine the required dimensional ratio (DR) to withstand the grouting pressure and installation forces;
- l) The pipe insert liner size shall be the maximum allowable internal diameter liner size that will fit the host pipe or box culvert as per the manufacturer's specifications unless specified otherwise in the Contract Documents;
- m) Demonstrate, in conjunction with the manufacturer's specifications, that the heat resistance of the pipe material is sufficient to tolerate, without damage, the heat of hydration generated by the grout curing;
- n) Dewatering or temporary flow by-pass plan, when specified in the Contract Documents;
- o) A containment and contingency plan in conformance with the Contract Documents for the following potential conditions:
 - i) Improper placement of the pipe insert liner.
 - ii) Damage to the host pipe or box culvert.
 - iii) The liner's failure to achieve the intended use.
 - iv) Potential environmental impacts and emergency containment and clean-up procedures.

466.04.02**Submission Requirements****466.04.02.01****Product Data**

A minimum of 2 weeks or as per the Contract Documents, manufacturer's product data and installation instructions including handling and storage requirements shall be submitted to the Contract Administrator.

466.04.02.02 Certifications

Installation shall be preformed by a licensed installer of the pipe insert liner. The following shall be submitted to the Contract Administrator:

- a) A letter of certification from the manufacturer that the product meets or exceeds all technical and packaging requirements.
- b) Manufacturer's certifications that materials have been approved for the installation conditions shown on the Contract Drawings and as specified herein.
- c) Manufacturer's materials warranty certificate.
- d) Installer's job history, reference certificates, and a certified statement from the manufacturer that the installer performing the work has been trained and approved in the handling and installing of the product to be used. Certification letter shall be dated within 6 months of the bid date.
- e) Proof of any necessary federal, provincial, or local permits or licenses necessary for the project.

466.05 MATERIALS

466.05.01 Grout

Grout shall conform to the pipe manufacturer's recommendations and specifications.

Grout's density shall be as per the Contractor's design submission and site conditions.

Calculations for the theoretical volume of the grout required to fill the annular space based on the pipe insert liner specifications and the field measured dimensions of the interior of the host pipe or box culvert.

Grout mix design shall be chemically and thermally compatible with all pipe systems.

466.05.02 Pipe Insert Liner

The Pipe insert liner shall be either:

- a) Corrugated steel pipe (CSP) according to OPSS 1801;
- b) Smooth walled steel pipe according to OPSS 1802;
- c) High density polyethylene (HDPE) according to OPSS 1840 or 1842;
- d) Polyvinyl chloride (PVC) pipe products according to OPSS 1841; or
- e) Non-pressure polypropylene (PP) plastic pipe products according to OPSS 1843.

No styrene based cured-in-place pipe liners (CIPP) shall be utilized anywhere in the Work.

466.05.03 Delivery of Materials

When the delivered quality of certified pipe insert liner product is deemed to be unacceptable by the Contract Administrator, the product shall be rejected.

466.05.04 Transporting, Unloading, Storing, and Handling Materials

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

466.07 CONSTRUCTION

466.07.01 General

The Contract Administrator shall be notified, minimum of 48 hours, in advance of starting the work. The exact size and length of all existing pipes and culverts to be rehabilitated shall be confirmed prior to installation. All required equipment shall be on-site and in satisfactory working order prior to commencing the installation of a lining section.

Appropriate grouting procedures (e.g. grouting in thin layers with effective pressure controls) shall be adopted during the construction phase to reduce the risk of compromising the structural integrity of the liner pipe and liner flotation.

Any joints shall be as per the manufacturer's recommendations, shall be watertight, interlocking, and shall not increase or decrease the inside or outside diameter of the pipe insert liner.

The product shall be protected from damage during the pullback operation.

The minimum allowable bending radius for the product shall not be exceeded.

466.07.02 Site Preparation

Site preparation shall be according to OPSS 490.

466.07.03 Preservation and Protection of Existing Facilities

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

466.07.04 Dewatering

When required, flow diversion, unwatering/dewatering, shall be installed to fulfill the Contract requirements. Dewatering when required shall be according to OPSS 517.

The Environment Canada weather forecast shall be monitored prior to commencement of lining operations. Where the anticipated weather conditions are such that anticipated host pipe/box culvert flows may exceed the installed bypass pumping capacity or may cause potential site flooding, commencement of construction shall be delayed until favourable weather is forecast.

466.07.05 Temporary Protection Systems

The construction of all protection systems shall be according to OPSS 539.

466.07.06 Cleaning of Host Pipe

The host pipe or box culvert cleaning shall be according to OPSS 411.

466.07.07 Preparation and Pre-Lining Repairs

Prior to liner installation, the host pipe or box culvert shall be inspected using visual observations or when specified, CCTV/zoom camera, especially where personnel entry is impracticable. CCTV inspection shall be according to OPSS 409.

Any open joints and voids shall be sealed with approved material prior to the lining of the host pipe or box culvert. If required, non-destructive testing (e.g. InSight™ Lite, Backscatter Computed Tomography, endoscope camera inspections, or other testing methods approved by the Contract Administrator) shall be performed to confirm that all identified voids and low density soil areas have been successfully filled with the approved material.

If additional repair procedures are required to restore the host pipe or box culvert for lining, for example invert reconstruction, a repair plan shall be submitted to the Contract Administrator prior to proceeding.

All active infiltration shall be sealed prior to application of the pipe insert liner material and ensure that the host pipe or box culvert is sufficiently dewatered as per the manufacturer's instructions.

Additional materials including quick setting mortars, chemical grouts and hydraulic cements necessary to stop infiltration and create a surface for the pipe insert liner shall be applied and shall be in accordance with the relevant standards. All products used to stop active infiltration shall be approved by the Contract Administrator and used in accordance with the manufacturer's recommendations.

The diameter, profile, length and all other dimensions of all host pipes or box culvert to be rehabilitated shall be accurately measure for planning all construction activities and choosing appropriate equipment.

The Contract Administrator shall be provided with the assistance and access necessary to check the layout of the pipe installation and associated appurtenances.

466.07.08 Construction and Operational Constraints

The sections shall be limited in length such that the pipe insert liner can be installed in the space available at the end of the host pipe or box culvert. Any necessary excavation shall be approved in writing by the Contract Administrator prior to commencement of such excavation.

All activities shall be confined to the designated Working Areas.

All work, especially the grouting of the annular space, shall be carried out in dry conditions.

The annular space shall be filled with grout as required to ensure that the space is completely filled and free of air voids. Grout shall be sufficient to form a solid gap filling material, prevent ground convergence around the pipe and subsequent ground surface subsidence and prevent long-term water flow at the outside boundary of any pipe and the ground.

During the installation process, the maximum axial/compression forces and bending moments shall not exceed tolerable limits of the host pipe or box culvert in order to avoid damaging the host pipe or box culvert.

Bulkheads shall be constructed at the ends of the host pipe or box culvert in order to contain the flowable concrete used for grouting. The bulkheads shall be designed for the weight of the flowable concrete under pressure. The bulkheads shall be completely removed after the grout has cured.

The actual volume of grout shall be accurately measured during the grouting procedure and compared to the theoretical volume. If volume of the grout placed varies by more than 10% from the theoretical volume, a written explanation for the discrepancy shall be provided to the design Engineer and the Contract Administrator.

Within 24 hours of the grouting of the host pipe or box culvert, MTO form PH-CC-701, Request to Proceed and a letter providing the theoretical and actual grout quantities shall be submitted to the Contract Administrator, confirming that the work was carried out as specified in the Contract Documents. The grouting process will be considered complete only when MTO form PH-CC-702, Notice to Proceed has been received from the Contract Administrator.

If required, the host pipe or box culvert's ends shall be removed and reinstated or replaced to facilitate the installation of the new pipe insert liner. Removals shall be according to OPSS 510.

Streambed material shall be placed to restore the elevation at the culvert ends to match reaches immediate upstream and downstream.

Lateral connections, as may be visible in the pre-lining video inspection, shall be reinstated using remote robotic devices. Only experienced operators shall make robotic connection reinstatements.

466.07.09 Supervision

The Superintendent shall have received adequate training from the technology supplier and shall have a minimum of 3 years demonstrated experience on projects with similar scope and complexity.

466.07.10 Site Restoration

Site restoration shall be according to OPSS 492.

466.07.11 Environmental Protection and Contingency

Environmental protection requirements and mitigation measures shall be according to the Contract Documents with the following additions:

- a) Install containment measures to prevent the escape of grout from the host pipe or box culvert undergoing pipe insert liner procedure.
- b) Reinstatement water flow no sooner than 24 hr after installation of the pipe insert liner and as per the manufacturer's recommended schedule.
- c) Capture and properly dispose-off the rinse/first flush water until pH levels are confirmed to be at or below a pH level of 9.

466.07.12 Electrical Equipment, Fixtures and Systems

Electrical equipment shall be suitably insulated for noise reduction. Noise produced by electrical equipment must comply with local municipal noise by-laws.

466.07.13 Management of Excess Materials

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

466.08 QUALITY ASSURANCE

466.08.01 Grout

All QA sampling and testing of the installed grout shall be in accordance with the applicable ASTM test methods and the grout manufacturer's specifications and design recommendations to confirm compliance with the requirements specified in the Contract Documents.

The Contract Administrator or designated representative shall witness the sampling and administer as specified in the Contract Documents. Samples shall be delivered to the laboratory within 24 hours of sampling.

Samples shall be taken during the actual grouting operations. A minimum of two sets of three cubes shall be cast for quality assurance. One set shall be tested after 7-Days and one set shall be tested after 28-Days. Tests results shall be forwarded immediately to the Contract Administrator.

The Contractor shall cast an additional two sets of cubes to be tested at the discretion of the Contract Administrator for quality assurance purposes.

In addition to the quality control, and testing measures put in place by the Contractor during and following the pipe insert liner operations, if required, non-destructive testing/imaging shall be performed upon completing the grouting operation for the pipe insert liner as a quality control measure to confirm that the grouting process was completed as specified, and to confirm if any voids are present within the annular space. Imaging or mapping shall be completed using endoscope camera inspections, Inversa System Ltd.'s (Inversa) patented InSight™ Lite and/or Backscatter Computed Tomography (BCT) technologies, or an approved equal. The non-destructive imaging or mapping shall provide clear and conclusive diagnostic imaging, and graphical representation that display the grouting assessment information in a format that is easy to interpret.

Based on the results of field inspection, the non-destructive testing, and the desktop analysis, the Contract Administrator will determine if additional grouting of the annular space is required. If additional grouting is required, the Contractor shall perform the additional grouting as indicated by the Contract Administrator.

466.08.02 Inspection of Materials

The pipe insert liner materials shall be subject to rejection by the Contract Administrator at any time on account of failure to meet any of the requirements in the Contract Documents, even though samples may have been accepted as satisfactory at the place of manufacture. Materials rejected after delivery shall be marked for identification and shall be removed from the job site at once.

466.08.03 Closed-Circuit Television (CCTV) Inspection

Lined host pipe or box culvert with pipe insert liner shall be inspected using visual observations or specified CCTV/zoom camera where personnel entry is impracticable. CCTV inspection shall be according to OPSS 409.

In the case of repairs required to restore the host pipe or box culvert for lining, such as joints sealing, invert reconstruction, or additional repairs etc., a post preparation CCTV inspection shall be completed for each host pipe or box culvert, when specified in the Contract Documents.

466.09 MEASUREMENT FOR PAYMENT

466.09.01 Actual Measurement

466.09.01.01 Pipe Insert Liner

Measurement for payment shall be the length in meters of the pipe insert liner placed, as measured along the centerline of the invert of the host pipe or box culvert.

466.09.02 Plan Quantity Measurement

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

466.10 BASIS OF PAYMENT

466.10.01 Pipe Insert Liner - 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.