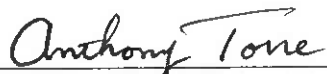


|                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                    |                                                                                                                                                                                            |                            |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|
| <b>SUPERSEDED BY</b><br><b>EB 15-031</b><br><b>EFFECTIVE 9/28/15</b>                                                                                                                                                                                                                                                                                                                     |  | New York State<br>Department of<br>Transportation<br><b>ENGINEERING<br/>         INSTRUCTION</b>                                                                                           | <b>EI</b><br><b>11-002</b> |
| <b>Title: REVISIONS TO STANDARD SPECIFICATIONS 602 – REHABILITATION OF CULVERT AND STORM DRAIN PIPE</b>                                                                                                                                                                                                                                                                                  |                                                                                    |                                                                                                                                                                                            |                            |
| Target Audience :<br><input checked="" type="checkbox"/> Manufacturers (18)<br><input checked="" type="checkbox"/> Local Govt.(31)<br><input checked="" type="checkbox"/> Agencies (32)<br><input type="checkbox"/> Surveyors (33)<br><input checked="" type="checkbox"/> Consultants (34)<br><input checked="" type="checkbox"/> Contractors (39)<br><input type="checkbox"/> _____ ( ) |                                                                                    | Approved:<br><br>Anthony Torre, P.E.<br>Acting Deputy Chief Engineer, Research<br>Date <u>04-02-2011</u> |                            |

#### ADMINISTRATIVE INFORMATION:

- Effective Date: This Engineering Instruction (EI) is effective beginning with projects submitted for the letting of 09/01/11.
- Superseded Issuances: None.
- Disposition of Issued Materials: The revisions issued with this EI will be incorporated into a future update of the Standard Specifications.

**PURPOSE:** This EI revises §602 - REHABILITATION OF CULVERT AND STORM DRAIN PIPE of the Standard Specifications.

#### TECHNICAL INFORMATION:

- Updated Design Guidelines for these items are being issued concurrently with EB 11-008.
- New Construction Inspection Manual (CIM) Guidance for these items will be issued with a future EI.
- Cost Impact: Savings will be realized if guidance for selecting the most appropriate rehabilitation methodology is followed and the contractor executes the work following the best recommended practice. Additionally, the clarity incorporated into the new specification should reduce costly misinterpretation issues during construction, resulting in further savings to the NYS taxpayers.
- Changes Being Affected By This Issuance: This issuance introduces new structural paving items, improvements to shotcrete lining methodology and new lining with High Density Polyethylene Pipe (HDPE) items. The revised Cured In Place Pipe (CIPP) lining specification section addresses significant changes in the CIPP lining practice as well as environmental concerns by introducing non-VOC, non-styrene resins in this process as well as how to handle the thermal loading as a result of disposing the curing water in the adjacent streams. This issuance also adds new lining with galvanized steel items while it removes aluminum lining items from the standard specification, as a result of past improper use. Aluminum items had been used repeatedly in the past in inappropriate (e.g. abrasive) environments resulting in reduced service life of the rehabilitated structure. These aluminum relining items can still be used via special specifications after approval by the Director of the Materials Bureau.
- Removed/replaced Specifications: Removes existing 706-06 "Polyester Formed in Place Pipe Liner" and replaces it with a new specification 706-09 "Cured In Place Pipe (CIPP) Liner".
- Revised Specifications: 706-10 Polyvinyl Chloride Pipe (relining). Two additional ASTM PVC items were added to the Material Requirements section of this specification.
- Paving Inverts with Portland Cement Concrete, 602.2001, has been disapproved and a new pay item, Structural Paving of Inverts with Portland Cement Concrete, 602.2002, has been added.

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**IMPLEMENTATION:** Disapproved and approved special specifications and pay items are on pages 3 through 8 of this EL.

**TRANSMITTED MATERIALS:** Attached are revisions of both the Metric and English versions of §602 - REHABILITATION OF CULVERT AND STORM DRAIN PIPE of the Standard Specifications. Attached also is a new Standard Specification §706-09 Cured in Place Pipe (CIPP) Liner, both Metric and USC versions.

**BACKGROUND:** Since the creation of Section 602 in 2001, these specifications have proven an effective tool for addressing the condition of New York State's culverts, a critical group of assets. Many changes in the way these specifications are used, and administered, have occurred since then, and the reissuance of this section reflects current best practices.

The following describes the problems with the current specification and how they are addressed in this new issuance:

**PAVING OF INVERTS:** In the currently approved specification, this term refers to an inadequate process, which does not restore any structural capacity to the culvert. Since the introduction of Section 602 in 2001, designers have provided notes on the plans to address this shortcoming.

**STRUCTURAL PAVING OF INVERTS:** In this issuance, this is a culvert specific design aiming at restoring the structural integrity of the invert of the rehabilitated culvert.

**LINING WITH SHOTCRETE:** In this issuance this item includes several alternate reinforcement and height of cover options, which provides designers additional flexibility to incorporate these items into a variety of site conditions.

**LINING WITH HDPE:** Two new items for HDPE pipe lining have been created in this issuance so that the designer can specify either the solid or the profile wall type as per the project's needs. This addition will minimize confusion and arbitrary item changes during construction due to the different dimensional criteria (primarily inside vs. outside diameter) each wall type uses.

**LINING WITH PVC PIPE:** Two new PVC pipe lining items have been added in this issuance to increase equivalent products availability.

**CIPP LINING:** The existing section on Lining with Polyester Formed in Place Pipe Liner is being deleted and is replaced in the new issuance with a section entitled Lining with Cured in Place Pipe. This change was dictated by the need to accommodate new environmentally friendly resins introduced in the markets over the past few years for CIPP lining work conducted in environmentally sensitive areas. Detailed Design Guidance on the use of the CIPP item is available in EB 11-008 which is being issued concurrently. A partially deteriorated design methodology, for CIPP work in concrete culverts ONLY, is also introduced.

**GALVANIZED STEEL STRUCTURAL PLATE PIPES AND ARCHES:** lining items have been added in this issuance, to address abrasion resistance and invert durability concerns for larger culverts. These items complement the only other uncoated steel relining item, namely the steel tunnel liner plate family.

**ALUMINUM PIPE:** All aluminum lining pay items have been deleted from the standard specification as stream carried bedload has diminished the expected service life in several rehabilitated installations. These aluminum items will still be available for use wherever their use is warranted thru the use of special specifications.

The new design guidance being issued with the companion EB 11-008 will assist designers in making better material and pay item choices for relining projects.

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**CONTACT:** For any questions on this EI please contact Ed Lucas at ([elucas@dot.state.ny.us](mailto:elucas@dot.state.ny.us) or 518-457-4590) or Michael Mathioudakis at ([mmathioudakis@dot.state.ny.us](mailto:mmathioudakis@dot.state.ny.us) or 518-457-9800) of the Materials Bureau.

- Disapproved Special Specifications –
  - 01602.90nnnn M- Lining Existing Culvert with Corrugated Structural Plate Arch,
  - 01602.9001 02- Lining Existing Culvert with Corrugated Metal Box Culvert Superstructure,
  - 602.9002nn02- Lining with Corrugated Metal Arch (metric),
  - 603.01 39 M- Rehabilitation of Existing Storm Drain Pipelines by Cured in Place Inversion Lining
- Disapproved Pay items (Metric & USC) –
  - 602.2001, Paving Inverts with Portland Cement Concrete,
  - 602.2513, Lining with High Density Polyethylene Pipe, 325 mm diameter
  - 602.3048, Lining with Polyvinyl Chloride Pipe, 1200 mm (48")
  - 602.35xx, Lining with Polyester Formed in Place Pipe Liner,
  - 602.40xx, Lining with Corrugated Aluminum Pipe Type IR,
  - 602.45xx, Lining with Aluminum Coated (Type 2) CSP Type IR, 12 gauge,
  - 602.47xxxx, Lining with Aluminum Coated (Type2) CSP Type IIR, 10 gauge,
  - 602.50xxxx, Lining with Aluminum Structural Plate Pipe (230x65), (9"x2 1/2")
  - 602.52xxxx, Lining with Aluminum Structural Plate Pipe Arch (230x65), (9"x2 1/2")
  - 602.600101, Lining with Aluminum Tunnel Liner Plate 3.18 mm thick, 0.125" thick
  - 602.600102, Lining with Aluminum Tunnel Liner Plate 3.81 mm thick, 0.15" thick
  - 602.600201, Lining with Aluminum Tunnel Liner Plate 4.45 mm thick, 0.175" thick
  - 602.600202, Lining with Aluminum Tunnel Liner Plate 5.08 mm thick, 0.20" thick
  - 602.600301, Lining with Aluminum Tunnel Liner Plate 5.72 mm thick, 0.255" thick
  - 602.65xx, Lining with Concrete-Lined CSP (68x13), (2- 2/3"x1/2")
  - 602.70xx, Lining with Concrete-Lined CSP (125x25), (5"x1")
- Disapproved Specifications (Metric & USC)
  - 706-06 Polyester Formed in Place Pipe Liner.
- New Pay Items (Metric & USC) -
  - 602.2002, Structural Paving of Inverts with Portland Cement Concrete,
  - 602.26xx, Lining with Smooth Wall High Density Polyethylene Pipe,
  - 602.27xx, Lining with Profile Wall High Density Polyethylene Pipe,
  - 602.36xx, Lining with Cured in Place Pipe (CIPP),
  - 602.37xx, Lining Concrete pipe with Cured in Place Pipe (CIPP),
  - 602.51xxxx, Lining with Steel Structural Plate Pipe with PCC Paved invert,
  - 602.53xxxx, Lining with Steel Structural Plate Pipe Arch with PCC Paved invert,
- New Specifications (Metric & USC)
  - 706-09 Cured in Place Pipe (CIPP) Liner

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**Approved 602.25xx pay items.** No new pay items have been added. The current pay items can be found in the pay item catalog on the NYSDOT website at [www.nysdot.gov](http://www.nysdot.gov).

**Approved 602.26xx pay items.**

| Item No. 602.26xx Lining with Smooth Wall High Density Polyethylene Pipe |          |
|--------------------------------------------------------------------------|----------|
| Diameter inches (mm)                                                     | Item No. |
| 18 (450)                                                                 | .2618    |
| 21 (525)                                                                 | .2621    |
| 24 (600)                                                                 | .2624    |
| 27 (675)                                                                 | .2627    |
| 30 (750)                                                                 | .2630    |
| 33 (825)                                                                 | .2633    |
| 36 (900)                                                                 | .2636    |
| 42 (1050)                                                                | .2642    |
| 48 (1200)                                                                | .2648    |
| 54 (1350)                                                                | .2654    |
| 60 (1500)                                                                | .2660    |
| 66 (1650)                                                                | .2666    |
| 72 (1800)                                                                | .2672    |
| 84 (2100)                                                                | .2684    |
| 96 (2400)                                                                | .2696    |

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### Approved 602.27xx pay items.

| Item No. 602.27xx Lining with Profile Wall High Density Polyethylene Pipe |          |
|---------------------------------------------------------------------------|----------|
| Diameter inches (mm)                                                      | Item No. |
| 18 (450)                                                                  | .2718    |
| 21 (525)                                                                  | .2721    |
| 24 (600)                                                                  | .2724    |
| 27 (675)                                                                  | .2727    |
| 30 (750)                                                                  | .2730    |
| 33 (825)                                                                  | .2733    |
| 36 (900)                                                                  | .2736    |
| 42 (1050)                                                                 | .2742    |
| 48 (1200)                                                                 | .2748    |
| 54 (1350)                                                                 | .2754    |
| 60 (1500)                                                                 | .2760    |
| 66 (1650)                                                                 | .2766    |
| 72 (1800)                                                                 | .2772    |
| 84 (2100)                                                                 | .2784    |
| 96 (2400)                                                                 | .2796    |

**Approved 602.30xx pay items.** No new pay items have been added. The current pay items can be found in the pay item catalog on the NYSDOT website at [www.nysdot.gov](http://www.nysdot.gov).

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### Approved 602.36xx pay items.

| Item No. 602.36xx Lining With Cured in Place Pipe (CIPP) |          |
|----------------------------------------------------------|----------|
| Diameter inches (mm)                                     | Item No. |
| 12 (300)                                                 | .3612    |
| 15 (375)                                                 | .3615    |
| 18 (450)                                                 | .3618    |
| 21 (525)                                                 | .3621    |
| 24 (600)                                                 | .3624    |
| 30 (750)                                                 | .3630    |
| 36 (900)                                                 | .3636    |
| 42 (1050)                                                | .3642    |
| 48 (1200)                                                | .3648    |

### Approved 602.37xx pay items.

| Item No. 602.37xx Lining Concrete Pipe With Cured in Place Pipe (CIPP) |          |
|------------------------------------------------------------------------|----------|
| Diameter inches (mm)                                                   | Item No. |
| 12 (300)                                                               | .3712    |
| 15 (375)                                                               | .3715    |
| 18 (450)                                                               | .3718    |
| 21 (525)                                                               | .3721    |
| 24 (600)                                                               | .3724    |
| 30 (750)                                                               | .3730    |
| 36 (900)                                                               | .3736    |
| 42 (1050)                                                              | .3742    |

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### Approved 602.51xx pay items.

| Item No. 602.51xx Lining with Steel Structural Plate Pipe 6" x 2"(150x50) with PCC Paved invert |         |         |         |         |         |         |         |
|-------------------------------------------------------------------------------------------------|---------|---------|---------|---------|---------|---------|---------|
| Diameter<br>inches (mm)                                                                         | Gauge   |         |         |         |         |         |         |
|                                                                                                 | 12      | 10      | 8       | 7       | 5       | 3       | 1       |
| 60 (1500)                                                                                       | .510101 | .510102 | .510103 | .510104 | .510105 | .510106 | .510107 |
| 66 (1650)                                                                                       | .510201 | .510202 | .510203 | .510204 | .510205 | .510206 | .510207 |
| 72 (1800)                                                                                       | .510301 | .510302 | .510303 | .510304 | .510305 | .510306 | .510307 |
| 78 (1950)                                                                                       | .510401 | .510402 | .510403 | .510404 | .510405 | .510406 | .510407 |
| 84 (2100)                                                                                       | .510501 | .510502 | .510503 | .510504 | .510505 | .510506 | .510507 |
| 90 (2250)                                                                                       | .510601 | .510602 | .510603 | .510604 | .510605 | .510606 | .510607 |
| 96 (2400)                                                                                       | .510701 | .510702 | .510703 | .510704 | .510705 | .510706 | .510707 |
| 102 (2500)                                                                                      | .510801 | .510802 | .510803 | .510804 | .510805 | .510806 | .510807 |
| 108 (2650)                                                                                      | .510901 | .510902 | .510903 | .510904 | .510905 | .510906 | .510907 |
| 114 (2700)                                                                                      | .511001 | .511002 | .511003 | .511004 | .511005 | .511006 | .511007 |
| 120 (3000)                                                                                      | .511101 | .511102 | .511103 | .511104 | .511105 | .511106 | .511107 |
| 126 (3150)                                                                                      | .511201 | .511202 | .511203 | .511204 | .511205 | .511206 | .511207 |
| 132 (3300)                                                                                      | .511301 | .511302 | .511303 | .511304 | .511305 | .511306 | .511307 |
| 138 (3450)                                                                                      | .511401 | .511402 | .511403 | .511404 | .511405 | .511406 | .511407 |
| 144 (3600)                                                                                      | .511501 | .511502 | .511503 | .511504 | .511505 | .511506 | .511507 |
| 150 (3750)                                                                                      | .511601 | .511602 | .511603 | .511604 | .511605 | .511606 | .511607 |
| 156 (3900)                                                                                      | .511701 | .511702 | .511703 | .511704 | .511705 | .511706 | .511707 |
| 162 (4050)                                                                                      | .511801 | .511802 | .511803 | .511804 | .511805 | .511806 | .511807 |
| 168 (4200)                                                                                      | .511901 | .511902 | .511903 | .511904 | .511905 | .511906 | .511907 |
| 174 (4350)                                                                                      | .512001 | .512002 | .512003 | .512004 | .512005 | .512006 | .512007 |
| 180 (4500)                                                                                      | .512101 | .512102 | .512103 | .512104 | .512105 | .512106 | .512107 |

### Approved 602.53xx pay items.

|                                                                                             |
|---------------------------------------------------------------------------------------------|
| Item No. 602.53xx Lining with Steel Structural Plate Pipe Arch 230x65 with PCC Paved invert |
|---------------------------------------------------------------------------------------------|

**Due to the number of size combinations for this item, pay item numbers will be generated by DQAB as needed. Consult with the Materials Bureau for standard industry sizes available.**

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**Approved 602.75xx pay items.** No new pay items have been added. The current pay items can be found in the pay item catalog on the NYSDOT website at [www.nysdot.gov](http://www.nysdot.gov).

**Approved 602.80xx pay items.** No new pay items have been added. The current pay items can be found in the pay item catalog on the NYSDOT website at [www.nysdot.gov](http://www.nysdot.gov).

Make the following changes to the Standard Specifications dated May 4, 2006:

**Delete** Section 602 Rehabilitation of Culverts and Storm Drain Pipe in its entirety and **Replace** it with the following:

## **SECTION 602 - REHABILITATION OF CULVERT AND STORM DRAIN PIPE**

**602-1 DESCRIPTION.** Rehabilitate culvert and storm drain pipe in accordance with these specifications, the contract documents, and as directed by the Engineer.

### **602-2 MATERIAL REQUIREMENTS.**

**602-2.01 General.** Materials requirements are specified in the following subsections:

|                                                                            |        |
|----------------------------------------------------------------------------|--------|
| Portland Cement Concrete                                                   | 501    |
| Shotcrete                                                                  | 583    |
| Concrete Repair Material                                                   | 701-04 |
| Vertical and Overhead Patching Material                                    | 701-08 |
| Grout Sand                                                                 | 703-04 |
| Cured in Place Pipe (CIPP) Liner                                           | 706-09 |
| Polyvinyl Chloride Pipe (relining)                                         | 706-10 |
| (Profile Wall)                                                             |        |
| (Corrugated)                                                               |        |
| High Density Polyethylene Pipe (relining)                                  | 706-11 |
| (Profile Wall)                                                             |        |
| (Smooth Wall)                                                              |        |
| Corrugated Steel Pipe                                                      | 707-02 |
| (Polymer Coated)                                                           |        |
| Tunnel Liner Plate (relining)                                              | 707-05 |
| Corrugated Structural Steel Plate for Pipe and Pipe Arches and Underpasses | 707-09 |
| Anchor Bolts for Corrugated Culverts                                       | 707-20 |
| Zinc Chromate Primer                                                       | 708-04 |
| Bar Reinforcement, Grade 420                                               | 709-01 |
| Wire Fabric for Concrete Reinforcement                                     | 709-02 |
| Stud Shear Connectors                                                      | 709-05 |
| Membrane Curing Compound                                                   | 711-05 |

**602-2.02 Grout for Annular Space.** Design the grout for the annular space between the existing pipe and new liner pipe in accordance with the pipe Manufacturer's recommendations. Calculate the required volume of grout based on the existing culvert/storm drain internal diameter (minus deformations) and the external diameter of liner pipe. All grout components must appear on the Approved List unless approved by the Director, Materials Bureau.

**602-3 CONSTRUCTION DETAILS.** Provide the Engineer, a minimum of 10 days prior to starting the work, a written proposal of how the work will be progressed. The proposal shall include dewatering of the pipe; procedures for maintaining line and grade of the lining pipe; pipe manufacturer's recommendations for the assembly of preapproved joints or joint fusion methods; bracing methods; grout mix design and void filling techniques. Such proposals are also required, regardless of the rehabilitation

method, for shotcreting, concrete, and void filling methods.

**602-3.01 Existing Pipe Preparation.** Dewater, clean and inspect the existing pipe. Determine the location of and remove obstructions that may prevent proper installation of the paving or lining material. Inspect small inaccessible pipes, generally less than 1200 mm in diameter, using a closed circuit television and camera to provide a visual inspection. Provide strutting and bracing as required to ensure stability of the pipe.

### **602-3.02 Handling & Installing Lining Materials**

**A. General.** Install each run of lining pipe with the same material for the entire run unless otherwise identified in the contract documents or approved by the Engineer. Do not allow water to flow along the invert during concrete or fill material placement.

**B. Structural Paving of Inverts with Concrete.** Apply §603-3.07 Concrete Paving for Corrugated Structural Plate Pipe with the exception of the following:

- Pave the area along the invert's periphery, providing concrete cover thickness over the crests of the corrugations and concrete reinforcement details as indicated on the plans. If welding has been used to anchor the reinforcement or studs on a galvanized section of the pipe, then upon completion of the anchoring, restore the coating in accordance with §702-02 Corrugated Steel Pipe, E. Coating Repair. Coating restoration is not required where mechanical anchoring of the reinforcement has been utilized.
- Use Class D, Class H or Class J concrete for paving of the invert.

**C. Lining with Shotcrete.** Apply all requirements of Section 583, Shotcrete with the exception of the following:

- Shotcrete may be used to line concrete pipes, stone arches and corrugated metal pipes.
- All reinforcement design and details (e.g. spacing, anchoring, etc.) will be indicated on the plans. If welding has been used to anchor the reinforcement or studs on a galvanized section of the pipe then upon completion of the anchoring, restore the coating in accordance with §702-02 Corrugated Steel Pipe, E. Coating restoration is not required where mechanical anchoring of the reinforcement has been utilized.
- Apply a minimum 50 mm thick shotcrete layer over the crests of the corrugations. The shotcrete layer limits along the periphery will be indicated on the plans.

**D. Lining with Cured in Place Pipe (CIPP) Liner.** The CIPP manufacturer's / installer's name shall appear on the Department's Approved List of Materials and Equipment, Rehabilitation of Culverts and Storm Drains section.

The CIPP installer shall provide the Engineer a report with design details and calculations for determining the minimum required thickness of the cured-in-place-pipe (CIPP) liner, the minimum internal pressure required to hold the wetted liner tight against the host pipe, and the maximum allowable internal pressure so as not to damage the wetted liner. All design calculations shall assume a fully deteriorated host pipe, unless Item 602.37xx, Lining Concrete Pipe with Cured in Place Pipe (CIPP), is specified. All liner installations require the excavation of a resin containment pit to facilitate the installer's collection and subsequent disposal of any waste (styrene or non-styrene) and / or curing water from the jobsite. When the liner curing is completed, the installer will remove all

waste prior to the lined pipe being put back in service. The plans will indicate the size of the excavation for the resin containment pit. The excavation, temporary storage of the fill and restoration of the downstream channel will be performed under Section 206-1.02, measured under 206-4.04 and paid under 206.04 *Trench, Culvert and Structure Excavation – O.G.*

Use a resin/liner system meeting the following criteria:

- System consists of one or more layers of flexible needled felt or an equivalent material as approved by the Materials Bureau.
- Liner is flexible enough to fit irregular pipe sections and able to negotiate pipe bends.

Liner's surface must be coated with a plastic material compatible with the proposed resin. All liners containing styrene based resins require the use of a pre liner, to be inserted into the existing pipe before insertion of the CIPP liner. In addition to the pre liner, single or double sided liners may be specified in the contract plans, depending on the environmental settings of a particular application.

A thermoset resin and catalyst or an epoxy resin and hardener system, compatible with the proposed inversion system shall be used. If indicated in the contract documents, a resin containing less than five percent volatile organic compounds (VOCs) with less than 0.1 percent hazardous air pollutants (HAPs) and less than 0.1 percent of water quality pollutants as listed in 6 NYCRR Parts 700-705 shall be supplied. If the resin type (styrene or non-styrene) is not specified on the plans, the installer has the option to select the resin type. Proposed resin shall be compatible with the proposed inversion process.

Vacuum impregnate the liner with resin. Use a volume of resin capable of filling all voids in the liner material at nominal thickness and diameter. Adjust this resin volume by adding a minimum of 5% excess resin to allow for changes in resin volume due to polymerization and for any resin migration into the cracks and joints of the original pipe.

**1. Installation.** A cured-in-place-pipe (CIPP) liner may be installed into the host pipe by hydrostatic head, air pressure inversion, or a combination of the two. Do not exceed the manufacturer recommended maximum pressure to the liner felt fiber during the inversion process. Pulled in place installations may be allowed if it is indicated on the contract documents or if the installer is given prior approval by the Director, Materials Bureau.

- a. Hydrostatic Head.** The standpipe height must be sufficient to maintain at least the minimum required pressure between the CIPP liner and the existing (host) pipe. The lower end of the liner must extend beyond the outlet end whenever possible. Where changes in elevation may create excessive stresses on the liner felt, the use of bulkheads may be necessary. Alternative installation methods using a hydrostatic head will be subject to approval by the Director, Materials Bureau.
- b. Air Pressure.** The liner may be inverted using air pressure to extend it to the termination point. The air pressure needs to be adjusted and sustained to a level capable of holding the liner against the host pipe regardless of the curing method proposed to be used.

**2. Curing.** Cure the liner by circulating heated water throughout the section. Uniformly raise the temperature of the water above the level required to cure the resin. Monitor and record both the temperature of the curing water exiting the heating source and the temperature of the curing water returning to the heating source. Monitor and record the observed temperatures by the remote sensors on the liner-host pipe interfaces, located in the upstream and downstream area of the pipe. The remote temperature sensors readings will be used for monitoring the progress of curing and its duration. The minimum curing time is the sum of the minimum recommended initial and post-curing times as per the liner resin supplier's recommendations. The onset of the initial curing approximately occurs when all remote temperature sensors register a temperature consistent with the "exotherm", which shall be included in the Manufacturer's recommendations. Post-cure the liner at least for the minimum post-curing time *and at the minimum post-curing* temperature level, as per the liner Manufacturer's recommendations. Add post-curing time for any deviations from the recommended post-curing temperature levels. All resin Manufacturers' curing proposals require approval by the Director of Materials Bureau prior to its initial use by the Department. Also, a new curing proposal submission for approval is required if an already approved liner Manufacturer introduces a new resin formulation and/or a new liner curing method to a Department contract.

**3. Water and Material Management.** After post-curing is completed, manage the curing water so that it does not cause or contribute to a violation of water quality standards to receiving waters or groundwater as per 6 NYCRR Part 700-704. In particular, the CIPP Contractor shall note the surface water quality and groundwater standards at 6 NYCRR Part 703 for pollutants such as styrene and thermal discharges. The CIPP Contractor shall enquire as to the classification of potential receiving surface waters in the project location if this information is not provided in the contract documents.

- A. Handling of curing water used in a styrene based thermoset resin liner installation:
  - 1. Collect and transport curing water from the site for reuse within another CIPP location; and/or
  - 2. Collect the water and dispose or treat at off site facilities. Transport wastewaters within vehicles that have a waste transporter permit 6 NYCRR Part 364. Off-site disposal shall be at a publicly owned treatment works or at a disposal facility permitted to accept the wastewater. The Contractor shall conduct off site treatment to reduce styrene concentrations to acceptable levels to meet water quality standards prior to discharge to the receiving waters; and/or
  - 3. Treat wastewater on-site to acceptable styrene and thermal loading and discharge to receiving waters in accordance with agreements received from the Regional NYSDEC Office.
- B. For curing water from non-styrene based processes, collect water for disposal off-site as described in A1 and A2 above or discharge on site if it does not contain pollutants that could cause or contribute to a violation of water quality standards. Reduce temperature to prevent a violation of the thermal standards to the receiving waters.
- C. Collect any excess resin and any curing materials at the upstream and downstream ends of the installation for disposal.

- D. Record and document quantities of curing water removed from the site. Provide record/documentation of the reuse and/or disposal facility and quantity disposed of curing water leaving the site.

After post-curing is completed, cool the liner to a temperature of 38° C prior to relieving the static head in the inversion standpipe. Cool-down may be accomplished by adding cool water into the inversion standpipe to replace warm curing water being removed from the liner. Contract documents may contain restrictions on the temperature of the released curing water or whether the curing water needs to be removed and treated. Any other proposed liner curing methods will be subject to the approval of the Director, Materials Bureau.

**4. Workmanship / Damage / Defects.** The finished pipe liner shall be continuous over the entire length of an inversion run and be free of dry spots, lifts and delaminations. If any dry spots, lifts and delaminations exist, remove the liner in those areas. Mark a line 1 m from both ends of the distressed area, cut the distressed area out, and replace it at no cost to the Department. If the Cured-In Place-Pipe (CIPP) liner does not fit against its termination point, seal the space between the pipe and liner with a resin mixture compatible with the CIPP. The liner may be sampled and tested for tensile and flexural properties in accordance with ASTM F 1216 at the discretion of the Department. Failure to meet the designed properties will be a cause for liner rejection.

**5. Storm Drain Lateral Connections.** Reconnect the existing storm drain lateral connections after the liner has been cured in place. Use robotic cutting devices to reestablish ties in non-man accessible pipes.

**E. Lining with a new Liner Pipe-General.** Before lining, pull or push a single piece of liner pipe through the existing pipe to verify liner clearance. The liner must be positioned and secured to facilitate its complete encapsulation by grout.

Follow the Manufacturer's recommendations for handling and assembling the pipe and all provisions included in the approved written proposal.

When required, reconnect existing storm drain lateral connections by utilizing an open cut excavation, internal connection or remote installation using robotics. Prior to filling the annular space, connect and seal all laterals between the new liner pipe and the existing lateral.

Grout the entire annular space. Provide a minimum annular space of 25 mm for grouting between the new and existing pipes. Provide details on how to hold the liner pipe to line and grade until the grout has set.

If the volume of the grout used is less than the anticipated (calculated) volume, or an inspection of the relined culvert indicates that there are voids in the annular space, the Contractor must provide the EIC with a plan to rehabilitate all identified voids. Depending on the location and size of the voids, additional grouting may be required in these areas. This may be accomplished by re-grouting in those areas from within the culvert. The voids must be filled to the satisfaction of the Engineer at no additional cost to the state. Grout that fills invert and connected voids is covered in the cost for these items.

**1. Lining with High Density Polyethylene Pipe.** Prior to lining, follow in its entirety all provisions of §602-3.02 E. Lining with a new Liner Pipe-General.

Reline with Smooth Wall Polyethylene Pipe or Profile Wall Polyethylene Pipe, as indicated in

the contract documents.

Install all pipe, fittings, adapters and appurtenances according to the Manufacturer's recommendations. Limit joint separations to less than 12 mm between adjoining sections. Field cuts will be permitted only at the terminal ends. No HDPE pipe sections less than 1 m long will be allowed in any lining project.

Perform all butt fusion, welding and extrusion welding of HDPE pipe in accordance with the Manufacturer's recommendation. A Manufacturer's representative – or an individual trained by the manufacturer – must be present at all times during any fusion or welding operations. Alternate joining methods will be subject to approval by the Director, Materials Bureau.

**2. Lining with Polyvinyl Chloride Pipe.** Prior to lining, follow in its entirety all provisions of §602-3.02 E. Lining with a new Liner Pipe-General.

Reline with a Profile Wall PVC Pipe or Corrugated Wall PVC Pipe with integral bell and spigot joints.

The installation proposal for this item to be submitted by the contractor for Departmental approval should in addition address the following PVC specific issues prior to any work approval is granted; Whether the PVC liner will be pulled or pushed through the culvert and the type of pushing or pulling ring/plate to be used; Whether a nose cone or a different device will be used in this process and how the jacking, pulling or pushing loads on the liner will be monitored in order to conform to the PVC liner's Manufacturer's specifications and guidelines. Include PVC liner's Manufacturer's specifications and guidelines in the submitted for approval proposal. Follow all Manufacturer's recommendations during joint assembly operations.

**3. Lining with Corrugated Metal Pipe.** Reline with Polymer Coated Corrugated Steel Pipe.

Prior to lining, follow in its entirety all provisions of §602-3.02 E. Lining with a new Liner Pipe-General.

Insert and brace the liner pipe to the specified line and grade, and align adjacent pipe sections such that port holes, if used, are placed as detailed in the contract plans (Alignment bolts are not adequate bracing by themselves). Sever all alignment bolts not fully turned out and grind them flush to the new pipe interior. If port holes are used, provide fittings and plugs compatible with the delivery equipment. Insert the plugs into the fittings as the operation is completed. Limit joint separations to 12 mm between adjoining sections. To ensure that grout remains in the annular space, place internal expanding joint bands with annular corrugations and foam gaskets at each joint. Before grouting the annular space, brace and strut the bands. Do not obstruct with any bracing material the flow of grout into the annular space. Remove the bracing, struts and bands upon completion of this work.

**4. Lining with Corrugated Steel Structural Plate Pipe and Pipe Arches with PCC Paved Invert.** Prior to lining, follow in its entirety all provisions of §602-3.02 E. Lining with a new Liner Pipe- General.

Align adjacent pipe sections such that port holes, if used, are placed as detailed in the contract plans. If port holes are used, provide port hole fittings and plugs compatible with the delivery equipment. Insert the plugs into the fittings as the grouting operation is completed. Alignment bolts are not adequate bracing by themselves. Sever all alignment bolts not fully turned out and grind them flush to the new pipe interior. Do not obstruct with any bracing material the flow of grout into the annular space. Once lining with this item has been completed, apply §603-3.07 Concrete Paving for Corrugated Structural Plate Pipe and as indicated in the contract documents.

**5. Lining with Steel Tunnel Liner Plate.** Prior to lining, follow in its entirety all provisions of §602-3.02 E. Lining with a new Liner Pipe-General.

Line with tunnel liner plates (double flange). Use a lap type longitudinal seam. Fabricate the lap to allow a continuous cross section of the plates through the seam. Use an offset depth equal to the metal thickness for the full width of plate, including flanges. Drilling, punching or drifting to correct defects in manufacturing will not be permitted. Plates with improperly punched holes will be rejected.

Use 5 bolts per 450 mm width of plate in each lapped longitudinal joint and stagger the bolts in the ridges and valleys. Follow the Manufacturer's recommendation for circumferential and longitudinal bolt spacing.

**602-3.03 Damaged Pipe and Repair.** Repair all damage to the existing host pipe that is strictly obstructing the progress of the relining operation. Repair any damage to the newly installed liner caused during construction, consistent with the recommendations of Section 603-3.04 Damaged Pipe and Repair.

#### **602-4 METHOD OF MEASUREMENT**

**602-4.01 Lining with new pipe.** This work will be measured as the number of meters along the bottom centerline, measured to the nearest meter.

**602-4.02 Paving inverts.** This work shall be measured as the number of square meters determined by the paved width measured along the pipes interior circumference at the top of the corrugations and the length along the centerline of the pipe measured to the nearest square meter.

**602-4.03 Shotcreting.** This work shall be measured as the number of square meters determined by the shotcreted width measured along the pipes interior circumference at the top of the corrugations and the length along the centerline of the pipe measured to the nearest square meter.

**602-5 BASIS OF PAYMENT.** Include the cost of furnishing all labor, materials, and equipment necessary to complete the work in the unit price bid. Include the cost of all fill material needed to fill the annular space between the existing pipe and the liner pipe, dewatering and cleaning of existing pipe and the removal of any obstructions, intrusions or damaged pipe prior to lining.

For Paving Inverts and Shotcreting, include the cost of furnishing all labor, materials and equipment necessary to complete the work for the unit price bid and include all necessary preparations such as dewatering and cleaning to the existing pipe.

For Cured in Place Pipe, include the cost of furnishing all labor, materials and equipment necessary to complete the work for the price unit bid. Also include all necessary preparations such as dewatering and cleaning of the existing pipe, all activities involving water treatment as well as water and waste transportation and disposal. The excavation for the resin containment pit, temporary storage of the fill and restoration of the downstream channel will be paid for under 206.04 Trench and Culvert Excavation – O.G.

***Payment will be made under:***

| <b>Item No.</b> | <b>Item</b>                                                                      | <b>Pay Unit</b> |
|-----------------|----------------------------------------------------------------------------------|-----------------|
| 602.2002        | Structural Paving of Inverts with Portland Cement Concrete                       | Square Meter    |
| 602.2101        | Lining Culvert with Shotcrete                                                    | Square Meter    |
| 602.25xx        | Lining with High Density Polyethylene Pipe                                       | Meter           |
| 602.26xx        | Lining with Smooth Wall High Density Polyethylene Pipe                           | Meter           |
| 602.27xx        | Lining with Profile Wall High Density Polyethylene Pipe                          | Meter           |
| 602.30xx        | Lining with Polyvinyl Chloride Pipe                                              | Meter           |
| 602.36xx        | Lining with Cured in Place Pipe (CIPP)                                           | Meter           |
| 602.37xx        | Lining Concrete pipe with Cured in Place Pipe (CIPP)                             | Meter           |
| 602.51xxxx      | Lining with Corrugated Steel Structural Plate Pipe<br>with PCC Paved invert      | Meter           |
| 602.53xxxx      | Lining with Corrugated Steel Structural Plate Pipe Arch<br>with PCC Paved invert | Meter           |
| 602.550101      | Lining with Steel Tunnel Liner Plate 3.43 mm thick                               | Square Meter    |
| 602.550102      | Lining with Steel Tunnel Liner Plate 4.17 mm thick                               | Square Meter    |
| 602.550103      | Lining with Steel Tunnel Liner Plate 4.55 mm thick                               | Square Meter    |
| 602.550104      | Lining with Steel Tunnel Liner Plate 5.31 mm thick                               | Square Meter    |
| 602.550105      | Lining with Steel Tunnel Liner Plate 6.07 mm thick                               | Square Meter    |
| 602.75xx        | Lining with Polymer Coated CSP 12ga, (68x13)                                     | Meter           |
| 602.80xx        | Lining with Polymer Coated CSP 12ga, (75x25) or (125x25)                         | Meter           |

Refer to Contract Proposal for full Item Number and full description.

**Delete** 706-06 Polyester Formed in Place Pipe Liner in its entirety from the Standard Specifications and **Add** the following:

### **706-09 Cured in Place Pipe (CIPP) Liner**

**SCOPE.** This specification covers the material requirements for cured in place pipe liners, or a resin and hardener system, used in rehabilitation of culverts and storm drains.

**GENERAL.** The flexible liner will be fabricated from one or more layers of polyester felt, or from an alternate material approved by the Director of the Materials Bureau. An impermeable material will be bonded to one or both sides of the felt liner. A styrene or a non styrene based thermoset resin and catalyst or an epoxy resin and hardener system, compatible with the proposed inversion process/system and curing method must be used. If indicated in the contract documents, a resin containing less than five percent volatile organic compounds (VOCs) with less than 0.1 percent hazardous air pollutants (HAPs) and less than 0.1 percent of water quality pollutants *as listed in 6 NYCRR Parts 700-705* shall be supplied. Proposed resin must be compatible with the proposed inversion process.

**MATERIAL REQUIREMENTS.** Supply a resin and hardener system material conforming to the following minimum values:

| <u>Property</u>       | <u>Standard</u> | <u>Required*</u> |
|-----------------------|-----------------|------------------|
| Tensile Stress, MPa   | ASTM D638       | 17               |
| Flexural Stress, MPa  | ASTM D790       | 30               |
| Flexural Modulus, MPa | ASTM D790       | 1700             |

\* If the submitted design calculations indicate that higher values for the above listed material properties were assumed, then the above listed values will become the minimum values for these liner material properties.

**BASIS OF ACCEPTANCE.** Acceptance of this material will be based on the manufacturer's / installer's name appearing on the Approved List for Rehabilitation of Culverts and Storm Drains. Application for approval and entering into the aforementioned list shall be in accordance with *Materials Procedure 04-001, "Approval Process for POLYESTER FORMED IN PLACE PIPE LINER 706-06"*

Under "706-10 POLYVINYL CHLORIDE PIPE (relining)" of the Standard Specifications, **delete** the MATERIALS REQUIREMENTS section and **replace** it with the following:

**"MATERIALS REQUIREMENTS.** The Polyvinyl Chloride pipe materials must conform to ASTM F1803 (Profile Wall), ASTM F949 (Corrugated), ASTM F679, or ASTM F3034. All materials supplied will be clearly marked with the appropriate ASTM as certified".

Make the following changes to the Standard Specifications dated May 1, 2008:

**Delete** Section 602 Rehabilitation of Culverts and Storm Drain Pipe in its entirety and **Replace** it with the following:

## **SECTION 602 - REHABILITATION OF CULVERT AND STORM DRAIN PIPE**

**602-1 DESCRIPTION.** Rehabilitate culvert and storm drain pipe in accordance with these specifications, the contract documents, and as directed by the Engineer.

### **602-2 MATERIAL REQUIREMENTS.**

**602-2.01 General.** Materials requirements are specified in the following subsections:

|                                                                            |        |
|----------------------------------------------------------------------------|--------|
| Portland Cement Concrete                                                   | 501    |
| Shotcrete                                                                  | 583    |
| Concrete Repair Material                                                   | 701-04 |
| Vertical and Overhead Patching Material                                    | 701-08 |
| Grout Sand                                                                 | 703-04 |
| Cured in Place Pipe (CIPP) Liner                                           | 706-09 |
| Polyvinyl Chloride Pipe (relining)                                         | 706-10 |
| (Profile Wall)                                                             |        |
| (Corrugated)                                                               |        |
| High Density Polyethylene Pipe (HDPE) (relining)                           | 706-11 |
| (Profile Wall)                                                             |        |
| (Smooth Wall)                                                              |        |
| Corrugated Steel Pipe                                                      | 707-02 |
| (Polymer Coated)                                                           |        |
| Tunnel Liner Plate (relining)                                              | 707-05 |
| Corrugated Structural Steel Plate for Pipe and Pipe Arches and Underpasses | 707-09 |
| Anchor Bolts for Corrugated Culverts                                       | 707-20 |
| Zinc Chromate Primer                                                       | 708-04 |
| Bar Reinforcement, Grade 60                                                | 709-01 |
| Wire Fabric for Concrete Reinforcement                                     | 709-02 |
| Stud Shear Connectors                                                      | 709-05 |
| Membrane Curing Compound                                                   | 711-05 |

**602-2.02 Grout for Annular Space.** Design the grout for the annular space between the existing pipe and new liner pipe in accordance with the pipe Manufacturer's recommendations. Calculate the required volume of grout based on the existing culvert/storm drain internal diameter (minus deformations) and the external diameter of liner pipe. All grout components must appear on the Approved List unless approved by the Director, Materials Bureau.

**602-3 CONSTRUCTION DETAILS.** Provide the Engineer, a minimum of 10 days prior to starting of the work, a written proposal of how the work will be progressed. The proposal shall include dewatering of the pipe; procedures for maintaining line and grade of the lining pipe, pipe manufacturer's recommendations for the assembly of preapproved joints, or joint fusion methods; bracing methods; grout mix design; and void filling techniques. Such proposals are also required, regardless of the rehabilitation method, for shotcreting, concrete, and void filling methods.

**602-3.01 Existing Pipe Preparation.** Dewater, clean and inspect the existing pipe. Determine the location of and remove obstructions that may prevent proper installation of the paving or lining material. Inspect small inaccessible pipes, generally less than 48 inches in diameter, using a closed circuit television and camera to provide a visual inspection. Provide strutting and bracing as required to ensure stability of the pipe.

### **602-3.02 Handling & Installing Lining Materials**

**A. General.** Install each run of lining pipe with the same material for the entire run unless otherwise identified in the contract documents or approved by the Engineer. Do not allow water to flow along the invert during concrete or fill material placement.

**B. Structural Paving of Inverts with Concrete.** Apply §603-3.07 Concrete Paving for Corrugated Structural Plate Pipe with the exception of the following:

- Pave the area along the invert's periphery, providing concrete cover thickness over the crests of the corrugations and concrete reinforcement details as indicated on the plans. If welding has been used to anchor the reinforcement or studs on a galvanized section of the pipe then upon completion of the anchoring, restore the coating in accordance with §702-02 Corrugated Steel Pipe, E. Coating Repair. Coating restoration is not required where mechanical anchoring of the reinforcement has been utilized.
- Use Class D, Class H or Class J concrete for paving of the invert.

**C. Lining with Shotcrete.** Apply all requirements of Section 583, Shotcrete with the exception of the following:

- Shotcrete may be used to line concrete pipe, stone arches, and corrugated metal pipes.
- All reinforcement design and details (e.g. spacing, anchoring, etc.) must be indicated on the plans. If welding has been used to anchor the reinforcement or studs on a galvanized section of the pipe then upon completion of the anchoring, restore the coating in accordance with §702-02 Corrugated Steel Pipe, E. Coating restoration is not required where mechanical anchoring of the reinforcement has been utilized.
- Apply a minimum 2 inch thick shotcrete layer over the crests of the corrugations. The shotcrete layer limits along the periphery will be indicated on the plans.

**D. Lining with Cured in Place Pipe (CIPP) Liner.** The CIPP manufacturer's / installer's name shall appear on the Department's Approved List of Materials and Equipment, Rehabilitation of Culverts and Storm Drains section.

The CIPP contractor shall provide the Engineer a report with design details and calculations for determining the minimum required thickness of the cured-in-place-pipe (CIPP) liner, the minimum internal pressure required to hold the wetted liner tight against the host pipe, and the maximum allowable internal pressure so as not to damage the wetted liner. All design calculations shall assume a fully deteriorated host pipe, unless Item 602.37xx, Lining Concrete pipe with Cured in Place Pipe (CIPP), is specified. All liner installations require the excavation of a resin containment pit to facilitate the installer's collection and subsequent disposal of any waste (styrene or non-styrene) and / or curing water from the jobsite. When the liner curing is completed, the installer will remove all